UTOMATIC DATA PROCESSING

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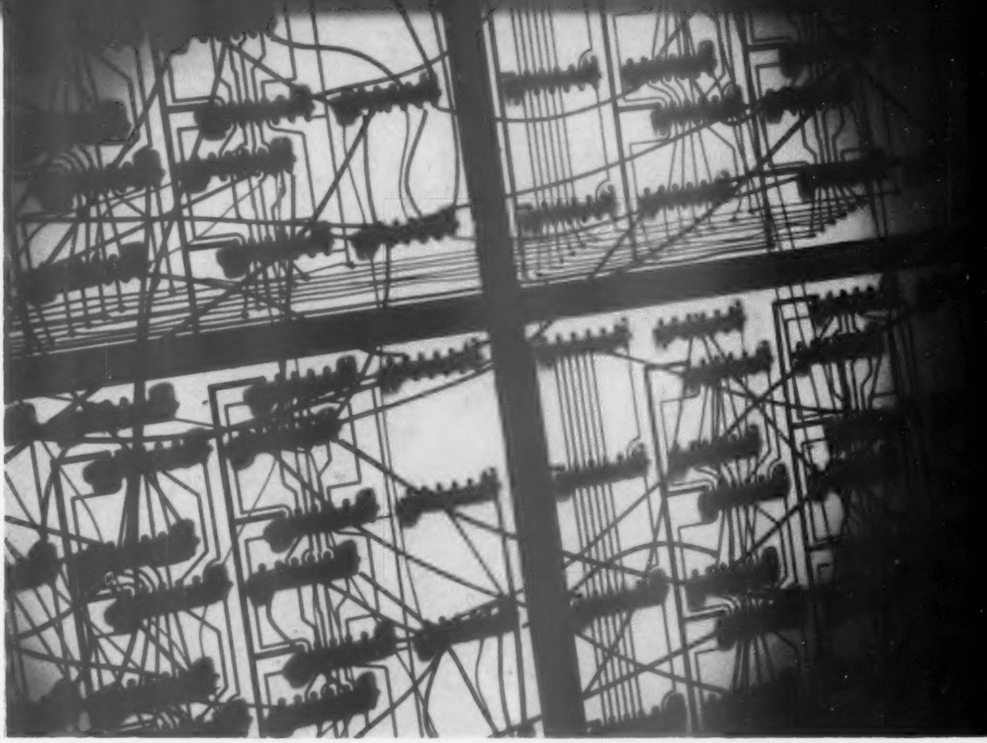

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Vol 1 No 4

Automatic
Data Processing

VOL I No 4 CONTENTS MAY 1959

COVER PICTURE

A pattern in electronics—the panel of a Hollerith computer.

AUTOMATIC DATA PROCESSING

Published monthly by Business Publications Ltd, registered office, 180 Fleet Street, London, EC4. Waterloo 3388). 45/- a year post free UK and overseas.

Advertisement, editorial and sales offices: Mercury House, 109-119 Waterloo Road, London, S.E.1. (Waterloo 3388).

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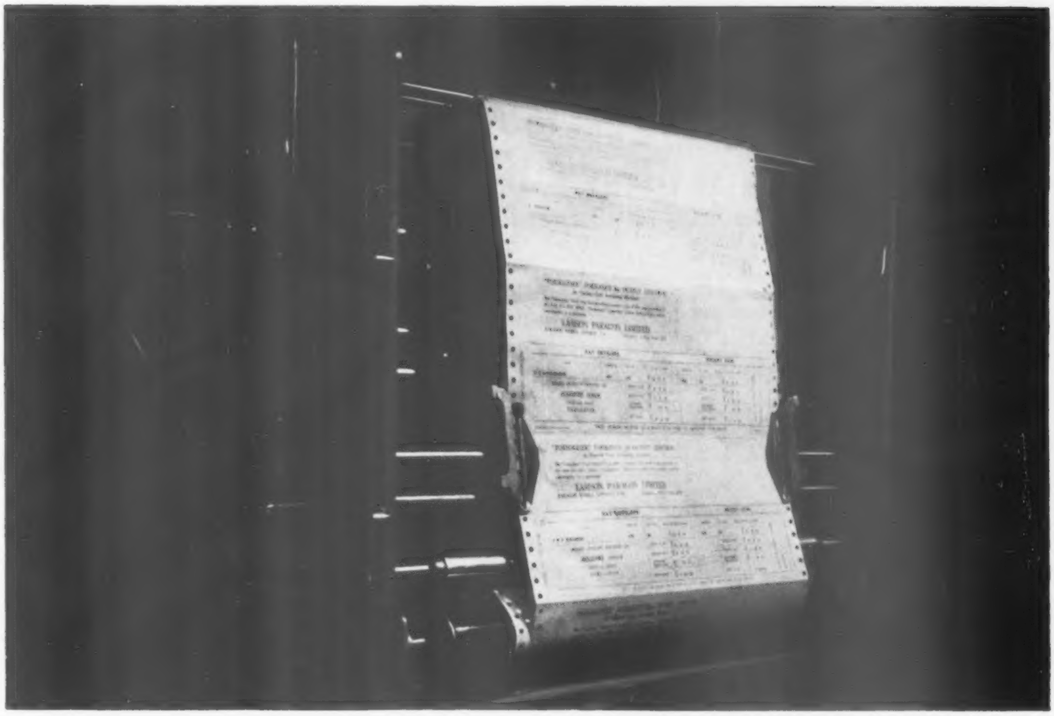

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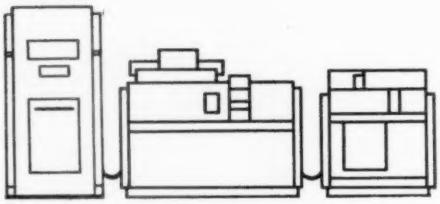

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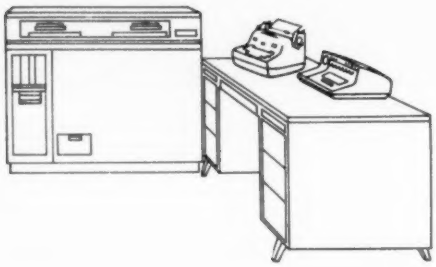

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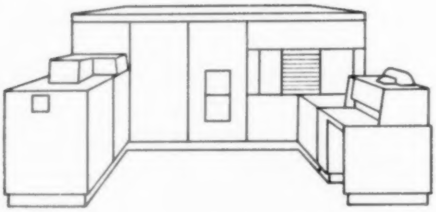

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COMMENT

Data: a Definition

A CONTRIBUTOR to this issue, in arguing for computer co-ordination in industry, opines that the term *automatic data processing* 'can be misleading, in that it appears to approve the using of computers to preserve industry's paper work, and even to increase it, despite the good intentions that began it all'. His fears may have substance: there have always been people with an insatiable greed for useless information, probably under the delusion that it will somehow give them more power, or more authority, or more prestige. There can be no guarantee that the computer will not be made to serve the obsessive ambitions of frustrated bureaucrats or, for that matter, a whole host of other unworthy purposes. But the object of automatic data processing is to add to the efficiency and to subtract from the drudgery of commerce and industry, not the reverse.

If *data* is the operative word in ADP, it is worth spending a moment or two on definition. It means not 'a mass of figures' but information; and information can be communicated without paper—by word of mouth, telephone, radio, or electronic impulses. *Data* can be a set of instructions given by a machine (a computer) to a bank of machines on the floor of the workshop. That, presumably, is the aim of fully automatic data processing in many industries. It is the logical progress from words (data) to action (automation).

Who Should Control?

NOT everyone, perhaps, will endorse the claim advanced by members of the Association of Certified and Corporate Accountants at Oxford during April that the co-ordination of data processing systems is *prima facie* an accountant's responsibility; but the fact that the claim was made is itself interesting and significant. The computer has already been recognised as a critical weapon in the struggle for power in the office.

The question of who should 'control' the automatic data processing system will be answered differently in different circumstances; but surely disaster awaits the firm that, by default, hands over control to the machine itself. Absurd as it may sound, the danger exists. It is reflected in an almost idolatrous attitude that is common enough in the commercial world to be faintly disturbing. It will do nobody any good to allow growth to the ridiculous notion that computers are superhuman 'brains'. They are machines, and like all machines they can be used intelligently or unintelligently.

ADP *or* Computer Co-ordination?

A computer is not a machine with a clearly definable function. It can do practically anything we like to choose for it. It is not a single *machine at all, but a communications system, and it is up to us to decide what machines to link to it.*

(Points from this article are taken up in COMMENT on page seven.)

by D G OWEN

COMPUTER APPLICATIONS MANAGER, THE UNITED STEEL COMPANIES LTD

THE term *automatic data processing* is with us to stay. Nevertheless, it is disliked in some quarters, for several reasons; this article is an attempt to explain these reasons, and particularly to put forward ideas on the proper role for a computer in an industrial company.

The words will, no doubt, continue to be used. But an examination of the meaning of the term *automatic data processing*, as a basis for discussing the approach to the use of computers that it exemplifies, is not out of place.

The first of the three words, *automatic*, is easily understood. The facility for repeating routine procedures as often as necessary is the first effect of introducing a computer to any task. It is the other words, *data processing*, that seem to me to need further definition. What does *data processing* mean?

A poll on this question would probably show a majority in favour of some such definition as 'the sorting, cross-referencing, filing, and summarizing of a mass of figures.' There would also, I think, be a large percentage of 'don't knows.'

If this is correct, most people are thinking of an ADP system as something that churns round and round, and in and out, a great quantity of figures, occasionally producing subtotals, and reprinting the figures from time to time in a different form. Much that has been said and written about using computers 'commercially' appears to bear this out.

Most people would also say that the aim of such a system is to augment clerical labour, to enable their offices to deal with more paper-work more quickly. 'More information for management' is the cry!

And if all this is what they really want, then ADP is a fine name for it.

In some businesses, perhaps, that *is* what is wanted; in a business where the stock-in-trade is itself information written on pieces of paper—a bank, or an insurance office—a machine which provides faster and more reliable handling, revision, and reproduction of documents would be engaging directly in production.

The Aims of Industry

But in industry the aim is *not* to produce documents; still less is it to produce still more documents. It is to produce cars or steel, petrol or cakes, electrical assemblies or jam-jars. Or money, if you prefer it that way, but not paper.

Data processing is therefore not an end in itself.

David Owen read Mathematics at Cambridge before the war. During the war years he was in the Operational Research Section of Bomber Command. He continued to do operational research work after the war when he joined the British Iron and Steel Association with whom he stayed until 1956, tending to specialise in computer applications towards the end of that period. In 1956 he joined Stafford Beer's Operational Research and Cybernetics Department, the United Steel Companies, as Computer Applications Manager.

Updating records and filing papers are only incidental to production, however much those of us who have engaged in such work or studied its methods may have come to believe otherwise.

Consequently, *automatic* data processing is an attempt at sub-optimisation: an attempt to improve existing office procedures in businesses which are primarily devoted to other ends. This is why the term ADP can be misleading, in that it appears to approve the using of computers to preserve industry's paper-work, and even to increase it, despite the good intentions that began it all.

It must be admitted that there is often a strong case for this kind of computer system, and in most companies it is not difficult to see how to inaugurate such a system quite quickly by suitable modifications to existing procedures and equipment. Alternative ways of using computers will clearly take longer to develop, and raise new and unwelcome technical problems, to say nothing of upsetting the traditionalists.

Despite this, alternatives are being examined, and some are even being installed. The big question in many industrial organisations is whether to go for the short-term (and less astronomically expensive) ADP type of computer system, or whether to attempt to redesign production establishments to work more or less indirectly under *computer control*.

It is sad that this question is only rarely being asked, let alone answered, to judge by published matter. I consider the main reason to be the mesmeric effect of the words *automatic data processing*.

Computer Co-ordination

If ADP is unacceptable as a system for an industrial company, an alternative must be offered. What follows is an attempt to show how the alternative system needs to differ from the usual conception of an ADP system, and for this purpose I use the name *computer co-ordination*. This term expresses one of the main aims of the system, and is chosen for that reason only.

As a starting point, I assume that the existing procedure is never a good guide for the design of a computer system. Exceptions to this rule are rare, but there is continual temptation to declare that one's own case is in fact exceptional in this respect.

Diebold admirably stated the case for this starting assumption, but there has since been a tendency to modify it in practice, and to pretend that 're-thinking' need not involve considering fundamentals.

Only by putting to one side, temporarily, the present office routines and management problems, can we assess at all objectively the long-term

prospects for computers in industry; and unless we do examine long-term prospects, we are unlikely to make the best short-term decisions.

All this vagueness stems from the fundamental fact that a computer is not a machine which has a clearly definable function that it performs. It can do practically anything we like to choose for it. I propose, therefore, to begin by attempting to define a computer in terms which will clarify the possible uses.

A computer is a group of machines so interconnected that one of them controls and uses all the others in accordance with a programme of man-given instructions. In this definition, the word 'machine' means simply any device which is capable of existing in two or more distinguishable states, and which can be changed from one state to another by an input signal.

In one guise or another, an instruction in the programme names component machines and says what information is to pass from one to another. A conventional example of this is an instruction naming a unit of storage and a card-punch, and stating that the binary pattern characterising the state of the first must now determine the state of the second machine also. That is, the instruction is to punch into a card the present contents of the storage unit.

Expansion by Components

It is easily acceptable that a card-punch should be a component machine in this group of machines called a computer. But there is no reason why we should not expand the group to include other, quite different machines, if only we can provide suitable connecting links along which the necessary amounts of information can flow. The collection of machines usually marketed as a computer is determined in great part by considerations of cost: it can be varied if it is worth while to do so.

The electric light switch by the door of the computer room might be connected as a subsidiary machine, and a programme could then cause the light to be switched on or off in certain circumstances. In that case, the boundary of the computer would have been extended to include the light switch.

In principle, the computer may be expanded indefinitely in this way, and the machines so linked together will be, *from the point of view of the computer* (if I may be permitted an anthropomorphism) as much a part of the computer as its multiplication circuits.

It is clear from this definition that a computer cannot be disposed of and treated as if it were 'just another machine.' It is not a *single* machine at all, but a communications system embracing an arbitrary number of machines, and it is up to us to decide which machines can best be linked to the system. The problems of input and output of information are somewhat changed when considered in this light.

At present, it is probably true to say that most processing machines are not yet 'ready' to be remotely controlled by a computer. It is well known that drilling and profiling machines have been built to be controlled by computers, but clearly there is a long way to go before the direct linking of production-line machines to computers becomes generally practicable.

However, there are ways round this problem. There are the machine operators. They can provide a vital part of the link with the computer without too much difficulty.

It is not, of course, enough to observe that a computer *could* in principle be in communication with all the important parts of a works, and could therefore exercise some degree of control over production. It has to be shown that this would serve some useful purpose; in any particular case, it will also have to be shown that there is sufficient to be gained to justify the expense and upheaval.

Suppose for a moment that a production department in a factory had been linked to a central computer. Each lathe or crane or furnace would be acting always on instructions from the computer, and would be 'monitored' by the computer so that as each job was done, the outcome and the fact that another could now be started would be available directly to the computer.

It makes very little difference whether we assume that the machines are directly switched on and off and adjusted by remote control, or whether the operators have these responsibilities as usual. In the former case, we have to imagine very intricate and expensive digital control equipment, while in the latter this would be replaced by equipment to display information to the operator and to receive back information.

Unified Control

The first and main effect that we can foresee on the performance of the plant would come through unification of control. Instructions would always be given in the light of far more complete knowledge of the situation than is possible normally. No operator would be given a job for which materials and equipment had not yet become available, and at the same time, once

material became available for a further process to be carried out on it, the necessary instructions would be given as soon as possible.

The *sequence* of production jobs would be controlled, which in many works would be something of a novelty.

Such a system would be likely to have a profound effect on work-in-progress stocks, idle time, and on scheduling orders to a delivery promise.

Any of these, according to circumstances, could represent a saving sufficiently great to make it worth while at least to examine the feasibility of bringing it about.

Secondly, this system would require the computer to be accumulating continuously in its storage system the progress of production, the levels of stocks, the times jobs have taken, and so on. It would therefore have all the basic information which the management wants analysed for cost accounting purposes, including the data for payroll. The ADP problem of how to get the necessary data into the computer for (e.g.) accounting purposes would be absorbed into the problem of constructing the links between the computer and the production units.

There are thus two main groups of consequences to be expected, if we can link computer and production machines:

(1) Co-ordinated control of the sequences of activities which make up the company's production; and
(2) production *in* the computer of all the basic data for management.

Great Value of Computer

In my own industry, iron and steel, the diversity of products and processes is so great that co-ordination, if achievable, would be of great value — much greater than any likely office economies. This is presumably not equally true throughout all branches of industry, although over a large sector one can see a similar variety of production to that in steel. Where this variety is such as to make production planning and programming a problem at present, it is almost certain that a computer system of this kind would effect a considerable improvement. Whether the improvement would be sufficiently valuable is another matter, and one that has to be considered locally.

The computer, then, emerges with a clear role to play in an industrial company: to co-ordinate and control production. The production units, or their operators, would be sent information on which to act, and would return information to the computer recording the outcome of the actions. Sometimes, also, messages would originate from the production line, and the computer would respond with the necessary information.

To carry out this co-ordinating function, the computer will have to work in 'real time,' and will operate continuously for as long as the plant operates. To achieve the necessary continuity there will have to be a standby computer if the plant is not to be halted by a computer breakdown.

There will also need to be spare capacity for preparing such documents and records and analyses as the management may require from time to time: these will be 'data-processing' operations, applied to the accumulated records.

Order acceptances, purchasing requirements, invoices, and payroll are the main items of documentation required to go outside the plant. These would form the main printed output from the computer system.

Input would similarly consist of orders, purchases, payments, and details of employees and wage-rates. Neither output nor input would involve an unmanageably large bulk of information.

Communications Equipment

Communications between computer and production staff or machines are clearly the problematic features of such a system. What kind of equipment would be required?

I have said that machines can be linked to the computer so as to become in effect parts of the computer. This requires two-way communication between computer and machine, of the same kind as occurs with the machines inside the computer. There needs to be a means of routing information *to* the machine or its operator, and of receiving information *from* the machine or its operator. (A unit of storage is a particular kind of machine: the information that was sent to it is received back unchanged.)

Basically, a machine has to have a similar relationship to the rest of the computer as a storage register, and also as the hand-switches which usually adorn the computer's control desk. The storage feature enables information to be routed to a given machine by sending it to a given 'address' in the store, preferably one where it will be preserved until over-written, and whence it is relayed automatically to its destination. This

last may be a visual display for the operator, or a printing device, or a process control unit which will react to digital input signals.

The hand-switch feature is for information coming in *to* the computer. If it is an operator who is sending messages, then an array of switches or buttons or knobs on a panel at his place of work would be a minimal form of the equipment.

A Hypothetical Application

As an example, let us consider a possible arrangement for linking a computer to a steel furnace, *via* the operators.

The most important information which the operators require to be given is the specification of the next cast that they are to make. In this case, the amount of information might well lead one to consider a teleprinter as a means of displaying the information from the computer. The information would have been derived within the computer from customers' orders, which specify steel quality and from schedules embodying the local melting shop practice as regards the use of pig-iron, scrap, etc.

The most important information required by the computer to enable it to carry out its co-ordinating functions consists of forecasts of how long the cast will take to produce. These forecasts will be needed in order to programme the work of the soaking pits and mills, which take steel from several furnaces; they are produced from observations of the state of the furnace and the material in it.

For this purpose, the operator needs to be able to send messages stating times of day to the computer, and it should not be too difficult or expensive to construct a clock which can be set by the operator to the desired time, and which transmits a binary-coded pattern (at least 11 bits) to a storage location in the computer whenever it is reset.

At the computer, the present state of the clock should be available as a special register. If there were too many connections of this kind, each conveying new messages only at infrequent intervals, a programme-controlled switch to any one of several such clocks might be preferable.

In other circumstances, for example at the soaking pits, where ingots are heated to rolling temperature, instructions to crane operators and others might be displayed more conveniently and directly as illuminated numbers indicating which ingot was next to be drawn and taken to the mill.

At a slabbing mill, it is already becoming possible to control the sequence of passes and adjustments to the rolls from punched cards or other digital inputs, and here complete computer control of the process can probably be achieved before long. The information returned to the computer would certainly include an indication of the weight and dimensions of the slabs produced by this operation, and, again, weighing machines with digital output already exist.

This excursion has gone far enough to show that many of the communication problems can be solved, at least provisionally, with existing equipment, and that more can be solved with not very elaborate new devices. This is not the place to go into technical details of these devices beyond observing that there are sufficiently widespread opportunities for them to justify the development work.

However, because a vital part of the equipment is its connection to the computer itself, it is obviously essential for the computer manufacturer to be closely concerned in its design. This I regard as one of the most pressing demands on computer manufacturers, for the development work cannot easily be undertaken by the potential customer, although he will have been responsible for the original specification.

Operational Research Trends

The opinions expressed in this article are my own, and are not necessarily shared by my colleagues. They are, however, strongly influenced by the present trends in operational research. In the large companies of the steel industry, operational research has very largely been concerned with designing and introducing more effective and comprehensive production control systems. Every new investigation makes it more apparent that there is much to be gained in that field which is only likely to be achieved with the aid of computers of one kind or another.

The communications equipment is equally essential, but less readily available, and the next steps towards the use of computers for co-ordination of production will be the design and construction of such devices as I have described.

I have suggested that this should not prove too lengthy a task. Some people will disagree, I know, but this is no time for pessimism. One scheme of this kind is seriously planned to be completed next year, and whether or not that particular target is reached, I am convinced that not many years need to elapse before computer co-ordination systems are a reality.

A monthly report prepared by the New York office of John Diebold and Associates

How Practicable is Integrated Data Processing?

INTEGRATED data processing in the full sense of the term is an ideal which has been brought into the realm of possibility for large business organisations by the development of electronic computers. An integrated system is the most sensible way of approaching the processing of business data. The old-fashioned one-man business of the artisan was fully integrated, and the departure from this was made necessary only when business grew to such proportions that time and space forced the breakdown of accounting functions. The only practical way to accomplish the volume of work was to break down the files so that each segment of the operation could have access to its information.

In a small business, employing a single bookkeeper, integrated data processing is usually practised. All the files are accessible to the bookkeeper; as an activity item is received, it can be processed against all the appropriate records and consequently all files are up to date at all times. A computer system which is performing integrated data processing operates in the same manner. Because of the speed and flexibility of the computer, the large volumes of data existing in large business firms can be handled similarly to the single bookkeeper method.

An integrated system is now theoretically possible. In practice, they are virtually non-existent, and a closer look at the supposedly integrated systems is often a rude shock. Integrated data processing has been discussed a great deal in terms of computer application. To date, most computers are performing isolated business applications, and in many cases are doing a good job within the limited sphere of that job. However, the gradual increase in the number of isolated computer applications does not lead to integrated data processing. This is the reason that so few integrated systems are in operation at this time. The general approach has been to get a 'bread and butter' job on the system and then expand to other applications as time permits. Without a master plan for the co-ordination of the existing and new applications, each new job takes the installation another step away from an integrated system.

Attempts at Integration

The one industry which has seen the need for an integrated approach is banking. The result here is that the progress of electronic data processing has been quite slow. In this industry, the slow

progress results from the lack of certain equipment that would permit fully integrated systems, the need to agree on standardised inter-bank methods, and the size of the planning task.

In general the United States has a few isolated examples of attempts at integration. The most frequently discussed is that of Sylvania Electric Corporation, and perhaps the most interesting aspect of their system is the degree to which it is centralised and the elaborate communication network that is required to keep the information flowing. Its success has not been so startling as to encourage many imitators.

The major reason that we have not seen integrated systems put into effect is that the planning and design of such an all-encompassing project is such a major undertaking in both time and money. Too many companies have approached the installation of data processing equipment in terms of immediate or isolated problems rather than in terms of the long-range picture. This, of course, is not necessarily a bad approach if the solution of these problems can justify the installation of equipment. The experience which is gained through the use of the equipment can be of great value for long-range planning in the future.

Thorough Approach

Currently, the general trend in investigation and planning for data processing is to a more thorough approach to the problem. Past experience has shown that installation of this equipment requires a great deal more analysis and planning than has been done heretofore. When the entire scope of the data processing system, including immediate and future applications, is not investigated and planned on a co-ordinated basis, it is difficult to obtain an efficient system. Additions of new applications will often require a re-thinking of current applications that result in major alterations to them. This, of course, means extensive reprogramming and changes in procedure which could have been avoided if the entire scope of the activity had been planned in the beginning. Even in an integrated system, it will almost always be necessary to convert the various areas of a system on a step-by-step basis; however, an efficient end product can be realised when the conversions are made according to a predetermined plan.

An example of the trend towards the thorough study approach to data processing is a medium-size manufacturing firm which is now very close to the equipment installation stage of their programme. The firm is a manufacturer of components that are partially stock items and partially adapted to specifications of customers. It has over 2,000 employees and an annual sales volume of about $30 to $40 millions. The firm has made an analysis of their entire system in terms of integrated data processing. Their approach has been a very thorough one and consequently *before the installation of any hardware* they have a well-defined picture of what the system can do for them, the expected cost factors involved, staff requirements and reductions, and the sequence and timing of each step in the conversion process. Their plan extends over a four-year period after equipment installation, during which time they expect to develop a fully integrated data processing system on a medium-scale computer. The system is outlined in the accompanying chart (pages 16 and 17).

Work on this project was begun approximately 18 months ago. At that time a team of five people, which was representative of the various operating departments, was chosen as a planning group. Their first step was to design objectives for the system. This involved discussions with management in order to determine where and what requirements and additional benefits might be derived from the installation of ADP equipment. An all-inclusive list of objectives was prepared as an ideal towards which the system was designed.

Objectives Stated

Objectives were set up for each area of the business: sales, engineering, manufacturing, finance and industrial relations. Within these areas, a finer breakdown was prepared. For instance, within manufacturing, objectives were determined for material control, production control, purchasing, industrial engineering, and tool engineering. At this stage, the feasibility of the objectives was not of major concern. The aim was, first of all, to list the absolute requirements and, second, to list the factors which are not presently available but which would be beneficial if provided. The list was finally submitted in complete form, showing about 150 individual objectives.

The individual objectives were detailed and precise, going to so fine a degree as: ' Place limits on dollar amount of each purchase order to ensure that proper authority will review large expenditures.' In addition, there were the basic objectives of the system, as follows:

1. Reduction of operating costs.
2. Reduction in time delays in data processing and reporting.
3. Improvement in operating controls.
4. Improvement in management reporting.

With these objectives defined, the systems design phase was begun. As the work progressed, the staff realised that some of the objectives could not be met; however, an effort was made to realise the maximum number of objectives within the limitations of the system. The limitations of the system were determined by costs that limited the company to a medium-scale machine. At a very early stage in the study, a specific machine system was chosen, largely through reliance on the manufacturer. This early selection certainly simplified the system design, although it did not necessarily result in selection of the most appropriate system of equipment.

Seven Phases

The system which was designed encompasses data processing for all the operating departments. The processing is divided into seven basic applications or operating computer runs, each co-ordinated with the input or output of associated computer runs.

1. Availability of Material

The primary purpose of the first phase of the system is to determine availability of material to fulfil incoming orders from customers and other departments. In the same run these orders are edited, priced and classified, despatch dates are determined, and stock inventory levels are checked to produce orders for replenishment when necessary. For those items which must be produced, the component inventory is tested for availability and the necessary production and purchase orders are initiated. The company has stated that the major advantages realised from this phase are increased accuracy and virtually automatic order processing, maximum compliance with customer delivery promises and balanced inventories at minimum costs.

2. Labour, Machine, Tools

The second phase of the system uses the material requirements determined in the first phase and translates these into labour, machine and tool requirements. This operation prepares the production papers and records production schedule as determined by these requirements. In addition to the preparation of the projected schedule, the in-process schedule is updated daily according to the completed operations. Rescheduling requirements are determined and detailed cost records are maintained according to this feedback information. Weekly, the entire production schedule information is examined and the appropriate orders are released for the coming week. As each project is completed, the record of the entire job, including cost and time data, is punched into cards to retain as a permanent record.

Advantages from this phase of the system are many. They include improved utilisation of production labour and facilities, automatic scheduling and processing of production data, improved cost control, and reduced inventories. The availability of historical data on production should provide the means of improving many aspects of the operation. It is felt that this phase of the system will provide a substantial part of the savings expected from the installation of electronic equipment.

Significant savings are expected from reduced inventories. These savings are not broad guesses. Instead, each inventory at each level of production has been examined under pre-computer and post-computer conditions. For each type of inventory, a careful estimate has been made of the number of days that would be saved from the process, and this calculation has provided a specific indication of how many days of supply could be removed from inventory.

3. Purchasing and Accounts

The third phase of the system deals with purchasing and accounts payable. The purchase requirements which were determined in the second phase are now recorded in the open purchase order file. Purchasing and receiving documents are prepared, past due shipments are noted, and vendor invoices are processed. The benefits realised in this phase are reduced lead time on purchase items and closer control of purchases. Purchasing papers are prepared automatically and accounts payable distribution is effected immediately. Purchasing sources have been standardised, with periodic review on the basis of supplier performance.

4. Orders, Invoices

The fourth phase of the system prepares the order acknowledgments and invoices, and pro-

cesses the accounts receivable file. An open order file is updated and used for releasing consignment papers at the proper time. Credit cheques are made at the time despatch orders are released and as confirmation of consignments are received, the customer invoices are prepared. In the same run credits to Accounts Receivable are processed so that that file is reviewed and brought up to date daily. This completes the daily order processing cycle.

Such benefits as the following are obtained in this phase: processing of data on day received, automatic order processing and billing, current credit cheques, and the availability of invoicing and receivables statistics.

5. Payroll and Staff Records

The next phase in the system provides integrated payroll, and employee records. The processing produces the weekly payroll, maintains the personnel records and produces comprehensive reports in this area.

Mechanisation of the personnel records is to provide the means of extensive personnel analysis for controlling staff turnover, filling job vacancies, and wage and salary administration.

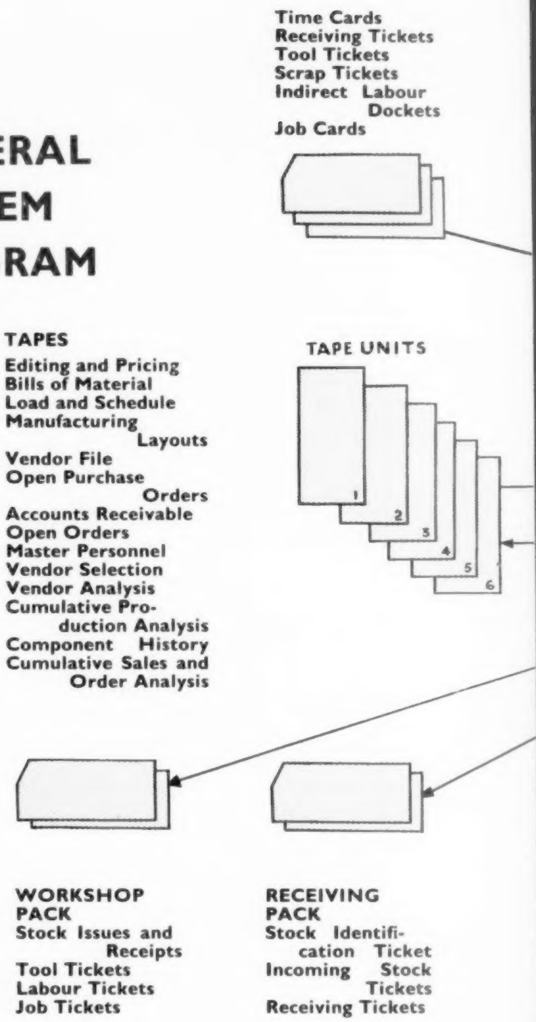
6, 7. Production Analysis etc.

The sixth and seventh phases of the system will use the data and files which are prepared during the daily computer runs. Production and purchasing analyses are performed by comparing the scheduled and actual activity. This production analysis should point out areas where improvements might be made and provide a means for follow-up on inefficient operation. Analysis of the purchasing activity can indicate performance ratings for vendors which can be used for the vendor selection process. It is felt that a direct cost saving can result from this phase of the operation if the statistics provided are used effectively.

The analysis of orders, sales and inventory completes the system's historical analysis. This phase of the operation is designed to produce product and component forecasts. The forecast requirements are combined with the present inventory levels so that requirements are not overstated. The net requirements are then used in the scheduling phase to determine production and purchase schedules for the coming period. In addition,

GENERAL SYSTEM DIAGRAM

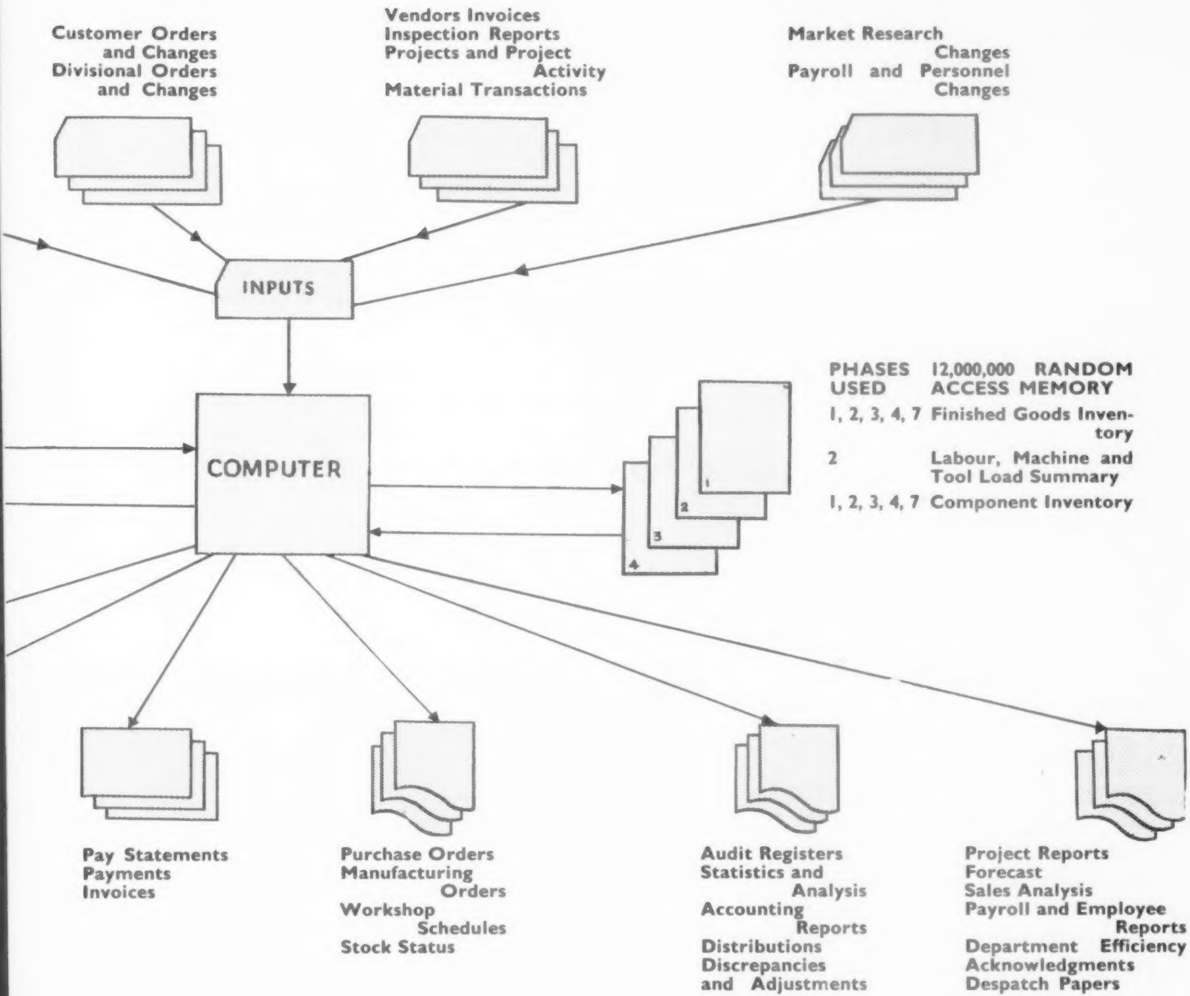
PHASES USED	TAPES
1	Editing and Pricing
2, 7	Bills of Material
2	Load and Schedule
2	Manufacturing Layouts
2	Vendor File
3	Open Purchase Orders
4	Accounts Receivable
4	Open Orders
5	Master Personnel
6	Vendor Selection
6	Vendor Analysis
6	Cumulative Production Analysis
7	Component History
7	Cumulative Sales and Order Analysis



analyses of out-of-stock and excess-on-hand conditions are used to revise re-order points and standard lead times and to review forecast inaccuracies. The major advantage provided by this operation is that it enables management to analyse future needs based on timely actual data.

Cost Study Made

Although the entire system, as finally designed, does not meet all the objectives originally set up by the planning committee, it was determined that the expected savings produced by installing the new system could certainly justify the use of the



equipment. A detailed cost study was made, comparing the old and new systems and a break-even point was estimated for three years and four months after installation. This point would be reached before all the planned applications were converted to the new system.

In addition to the cost study, a detailed schedule of time requirements has been made. Each stage of the conversion process has been analysed in terms of man hours required. The conversion plan covers a four-year period during which the integrated system described will be completed.

Although the system described is an integrated one, there were some areas of the operation which were not studied. In particular, the means of communication between central processing and the affected departments were not investigated. The incorporation of these departments is not contemplated at present, but the company plans an extensive study of many types of data transmission systems before the centralised system is put into effect.

It is always easier to develop an integrated system on paper than in practice, and the firm expects a great many difficulties in realising the system that it has planned. But difficulties arise whether one is undertaking an electronic system application by application, or on an integrated basis. Generally, the benefits are much greater from an integrated system.

Communicating with a Computer

by CLIFFORD METCALFE

CLIFFORD METCALFE, CBE, managing director of EMI Electronics Ltd and joint managing director of EMI, was born in Leeds 57 years ago. After leaving grammar school he studied engineering at technical colleges and joined the Bristol Aeroplane Company, where he worked on engine design.

He joined EMI in 1930 and was appointed managing director of EMI Engineering Ltd in 1952.

In the New Year Honours list in 1958 he was made a Commander of the British Empire for work in connection with British defence projects.

He is chairman of the Technical Computer Association and of the Electronic Forum for British Industry.

FOR the purposes of this article, computers will be divided into three classes. These are:

(1) The computer used for processing the paper work in a commercial office.

(2) The computer used operationally for controlling or assisting a manufacturing process.

(3) The computer in its use for planning, design, recording and analysis.

I The Office Computer

It is well known that in America there were several false starts in adopting computers, largely linked with the purchase of a machine, on prestige grounds, before studying the application. Here in Britain there has been a rather better tendency to do an assessment study, in all its aspects, before placing an order.

It is also well known that these studies on average result in reorganisation and streamlining of the office system, which in itself contributes a substantial fraction of the gain—in whatever form—of installing the computer. On the other hand any attempt to force the computer into the old pattern, without the step of rationalising in preparation, may well be disastrous.

From this it is clear that the most serious problems of this application lie in making the rest of the office routine talk the same language, both in syntax and in vocabulary, as the computer. In this metaphor the need for common syntax means the need to throw up the right type of information at about the time the computer needs to use it; by vocabulary we mean the details of the symbols, or other more artificial codes, by which the information is given from the human to the machine. The first is of course largely an Organisation and Methods function, but the point to bring out particularly here is that an office routine which, on its own account, would not be economical to transfer to a machine, becomes worth while when some of its input arises as a by-product of another routine, or where it prepares input for other activities. Hence it is essential to ensure that widely different facets of office work are kept integrated so that each contributes to the economy of the others.

On the matter of language, we can assume that data passing from one routine of the machine to another pass entirely in machine language. The problems are those of transfer between the humans with whom the data originate, and to whom they must finally flow, and the machine.

Translating for the Machine

Converting the information into machine coding is a laborious task, with many sources of error, and the need is to find an occasion, for each type of input, where it can be converted painlessly—and if possible reliably—as a by-product of an operation which is already essential. For example, if information has to be typed out at some stage, a paper tape can be punched at the same time. Or if a clock-card or a cash register slip has to be printed with the time or the charges for the sake of the employee or the customer, a dual purpose is fulfilled if the characters printed on the documents can be read by the computer. Or if characters are printed on cheques to aid in sorting and identifying the drawer's account, then the action of posting the amount to the payee's account can be used also to print a code, compatible with the pre-printed characters, which can serve in all the listing operations in passing through clearing to the paying branch.

Because of the inherent variation between the handwriting of different people—and indeed between the writing of the same person at different times and occasions—it will at least be a long time before the machine can accept uncontrolled manuscript as an input. The only way in which the human can enter information to the machine without mechanical aids is by marking cards in carefully defined locations, and even here care is needed to eliminate marks overlapping into adjacent areas.

With the mechanical assistance of something like a typewriter, the position is much better. The ideal from the machine point of view is that an unambiguous coded signal should be punched or marked simultaneously with typing legible characters, but it must be admitted that in some cases where the document gets into the hands of the public it is undesirable for it to carry important marks which are not in themselves intelligible to the layman.

Sensing Devices

Fortunately there are at least two British systems which enable the self-same marks to be read by the human and by the machine, in either optical

or magnetic form, without undue restriction on the accuracy of positioning during printing or reading. One of these devices developed by EMI is known as Fred (Figure Reading Electronic Device), and is capable of reading characters at the rate of many thousands per second. Applied directly to computers there is no doubt that machines of this kind will enable electronic data processing systems to work at something approaching their true efficiency, and not be restricted to the speeds of mechanical inputs as at present.

Specialised input devices must not, of course, be overlooked. An outstanding example is the type of keyboard proposed for use with airline reservation systems. Here each key has a separate meaning which is inherent in the key itself; one key represents dates or the day of the week, while another refers to a particular choice of journey out of those displayed. As is usual with specialised units, such a scheme only applies where quite a number of operators are following a very repetitive task.

Output Methods

At the other end the computer has to print out its results for human use. The shape of the output varies from continuous tabulation to the entry of single items on invoice forms, and from one-offs to large numbers of copies. No printer is yet made which is ideal for all these purposes. Those which are mechanical are comparatively slow and often noisy, while those which avoid intermittent mechanical motion and impact require some chemical or physical processing; this in turn limits both the number of copies and the freedom to skip rapidly over such areas as bill-heads where there is no printing-out to be done. In fact there is still a need for a major invention in this field of communication between the machine and the human user.

2 *Industrial Control Computers*

Within this grouping there is very wide variety. The inputs may be the readings of physical quantity, such as temperature or pressure in a chemical engineering plant, or an inspector's record of the number of articles accepted, as in a screw factory. The output may be used directly to control a flow valve or a heater unit, or may merely warn a supervisor to check the situation and see if he thinks he should take action to correct variations from programme. The common factor is that the computer works with the factory, on the same time scale; its work is almost invariably simple, and makes no particular demands on speed, but reliability is at a premium. While perfect reliability is impossible, the whole integration of computer and communication must be such that, in the event of failure, the factory can still work.

Many of the instruments for computer input already exist; others can be modified to this application as the need arises. In the discontinuous case, keyboard entry by the inspector may be best, or any of the automatic inputs by reading cards or tape or printed characters may apply. But the secret of the success of an integrated system, and efficient factory control, is that, wherever information is generated, it is in the one action made available for use in every process to which it is relevant.

3 *Miscellaneous Industrial Computers*

The only theme common to this group of computer uses is that they are not concerned in—or not responsible for—the moment to moment control of factory or office operations. An important family within the group is the computer used once and for all to design a factory or to verify the design of a new product, or used at seasonal intervals to show the best deployment of labour or the equipment of a company. The input may be a tentative design or the limitations imposed by plant capacity, and the output a fairly simple prescription; the computation can be quite involved but the input and output are easy.

The most important uses remaining are those of data logging and analysis. These can occasionally be needed in conventional factory work, but the real value is in nuclear plants, guided weapon firings and aircraft trial flights, where tests are destructive or where cost and safety impose strict limits on experiment, and the last crumbs of information have to be extracted from the available records. The quantity and rate of information may be high, but it need not be processed on the spot (except where it is information common to a control problem); the input problem is one of storage, and communication to a place where storage can be done economically. Once again, the success of a system like this depends on a thorough integration at the time of design to ensure that information can always flow freely to the place where it is needed.

Machine time can be hired at the rate of £35 an hour at National Cash's data processing centre in Marylebone Road, London

THE COMPUTER CENTRES AT WORK—3. **NATIONAL CASH**

A New Contender Enters the Time-hire Business

The third article in this series on the work of the computer centres describes the new business data processing centre recently established by the National Cash Company, and the company's outlook for computer ' laundrettes '

by PHILIP MARCHAND

EARLIER this month the latest computer service bureau to be established began operating when the National Cash Register Company started processing work for clients on a National-Elliott 405 machine at their Marylebone Road headquarters, London.

The company have in fact been running a demonstration centre, based on another 405 installation, for some time. However, this has been used largely as a shop-window display and for testing programmes on behalf of organisations about to install their own 405 systems. The second machine that has now been brought into their headquarters marks National Cash's more serious intent of entering the computer time-hire business.

Initially, some 12 clients are to use the service, and already the centre's machine has a full work schedule for the day shift that it will be worked. The company do not of course consider this as working the centre to capacity and intend to work

a night shift as soon as clients' work demands it, and extra operators have been trained.

Of the first service jobs at present being processed for clients, two are payroll calculations and the majority of the remainder are termed loosely by the centre as 'statistical work.' The first dozen contracts include regular weekly and monthly calculations, and also annual work and one or two one-shot jobs.

One yearly job the centre has taken on is the processing of examination results for two county education authorities.

The first organisations who will be using the centre represent a fair cross-section of the types of concern that are at present using business data processing services. They include a public utility, a manufacturer of electrical components, an insurance company, a branch of the armed services, a large hospital, a public opinion poll organisation, a firm of consultants engaged in operations research work, and a public transport company.

Centre Facilities

The company already operate a punching service to prepare punched cards for National Cash customers who have bought 405s but have not yet purchased their own punching equipment. Ten operators are at present employed by the service and this number is being increased to cope with the computer centre's card demand.

Programming clients' work is done by the centre, except when the client insists on doing this himself. The firm of consultants who are using the centre, for instance, opted to programme for the machine themselves. However, programming is considered as part of the service provided and the centre make use of some 20 programmers based on head office.

National cash have installed over 20 405s and have written many of the initial programmes for their customers. These provide the centre with the nucleus of a sub-routine library which can be used for clients' work. Where this is possible, adapting an existing programme for a client will cut considerably the usual hiatus between stating problems for the computer and running them on the machine.

For the preparatory work required before clerical work can be programmed and processed the centre has adopted the same approach as the computer sales organisation. A 'systems adviser' is sent to study clerical procedures or other work the client intends to automate. This study may

A Bull line printer (right) is one of the output machines at the centre's disposal. Eventually National Cash will have their own line printer, developed by the American company, and with an output rate of 600 lines a minute

Accounting machines that produce punched cards or tapes as a by-product have an important future, the company predict

take anything from a week to a month. The client is then sent a full report on the adviser's findings, outlining how the job will be done and approximately what it shall cost.

The hub of the centre is the new 405 installation. However, the demonstration machine will also be at the centre's disposal for testing clients' programmes, and—in cases of emergency—for processing data.

With regular work the centre will operate a shuttle service which will take in the raw information on original documents, punch this on to cards and then put the cards through the machine. The results, which are first recorded on to magnetic film, can either be transferred to paper tape or fed to a line printer. Either way the centre send back completed invoices payslips and management information printed out in the required format.

Wired Machines

Computer manufacturers today have to come into the computer time-hire business for much the same reasons that world powers have to be in the nuclear club—they cannot afford to be out of it; at present, some firms are making use of a number of service centres simultaneously, in order to assess machines and to gain working experience. So a centre is a sales necessity. National Cash admit candidly that they have come into time-hire principally to demonstrate what computers can do and thus encourage sales. However this is only one motive.

The company have done some cautious crystal-gazing and have come through convinced of the future of computer 'laundrettes.' This is seen as linked to the future of the 'wired machine.' A number of manufacturers including National Cash, have brought out adding and accounting machines which in addition to producing 'hard copy'—summation slips, invoices, payslips, etc—also produce punched cards or paper tape as a by-product. This development—which involved wiring up an adding or accounting machine to an automatic card punch combination or a paper tape recorder—will mean that from a straightforward job of producing invoices, for example, sales and stock-in-hand statistics could be abstracted from the cards or tape. This would be ideal work for a computer laundrette; several kinds of management figures can be obtained from the recording of normal clerical operations and the potential volume of work for a computer service centre is enormous.

However, to date, wired machines have only just begun to come off the assembly lines, and so their adoption by companies in this country is a matter for the future. Nevertheless, National Cash feel certain enough that rapid progress will be made with the new wired machines to be considering seriously setting up computer centres in the larger provincial cities.

CONTRIBUTIONS

The editor invites authoritative and thoughtful contributions on all aspects of automatic data processing. Factual accounts of first-hand experience in planning, installing and operating computer systems are particularly invited; but theories and prognostications based on practical experience in commerce, industry and government are also welcome.

Articles, preferably between 2,000 and 3,000 words in length, are most acceptable when typed with double spaced lines on plain quarto paper. They should be addressed to:

The Editor
AUTOMATIC DATA PROCESSING
Mercury House, 109-119 Waterloo Road,
London, SE1

Fully automatic process control is still in its infancy: computers will help towards more rapid development

Computers and Flexibility in Control

by **P L YOUNG**
ENGLISH ELECTRIC CO LTD

AN important new development in the use of computers is that of process control. They have been used in the last few years to control machine tools and now they are being applied to a number of industrial processes. There is an important difference between the two types of work. In machining one is concerned with three dimensions, or variables; in an industrial process there are generally many more.

The problem of control is much bigger in the second case. During the past 35 years industrial processes have been getting larger and more centralised. (Compare, for example, the present scale of electricity production and pattern of distribution with that existing under innumerable local bodies.) This has resulted in a tremendous increase in complexity. Many things have to be watched continuously. Pressures, temperatures, flow rates, liquid levels, voltages, and so on, have to be controlled by the appropriate instruments at several points in a factory process. For instance, on a modern blast furnace plant complete with coke ovens, power station, sinter and by-product plant there may be over 200 instruments and recorders. On a new chemical plant the cost of the instruments can be more than 15 per cent of the total cost of the plant.

With the interaction of so many devices there is a persistent tendency to instability, particularly at the beginning and ends of processes. If valves try to maintain a specified liquid level, this may cause the pressure and temperature to change, and the operation of pressure regulators and thermostats in an attempt to maintain their constants will in turn cause something else to change. The system is continually 'hunting,' seeking a state of equilibrium. This may mean that the end product is not of the desired value; its quality may be uneven or below standard. And in an extreme case such instability could give rise to a dangerous situation.

Need for Flexibility

The difficulty is that present process control devices respond in a pre-set way, performing a consistent function. They can only obey, not learn from experience. An operator must be able to give them the right initial instructions and also be able to change these instructions in the light of the changes which take place in a process as it goes on. A control system must be flexible.

At the same time control of complex processes, which occur in the chemical, oil, gas, electrical, nuclear and steel industries, is plainly beyond the range of human beings, both individuals and teams. Masses of data have to be collected, stored and analyzed quickly because corrective action must be taken with the least possible delay. These are tasks suitable for computers and in the field of automatic process control these machines have two important functions to perform.

Before a process can be controlled it is necessary to know precisely what is being controlled. One must have detailed knowledge of the

behaviour of a process. Its performance, particularly at times of instability, must be studied and analyzed.

To assess the effects of various factors, accurate and continuous measurements must be made over a fair period. A plant may be studied under normal working conditions or deliberate changes may be made for the purpose of experiment. It can be appreciated that the volume of data collected is considerable and that its analysis requires the use of an electronic digital computer. A data logger designed to record up to 50 measurements continuously recently spent 800 hours in the investigation of a particular chemical process. The data were recorded in digital form so that they could be fed directly into a computer, thus avoiding the immense manual labour of recording and transcribing the data, with the attendant risk of error.

This was for the full-scale analysis. Analogue computers enable theoretical assumptions to be checked quickly beforehand. They make possible a simulation of various operating conditions and a speedy examination of different possibilities. It is much simpler, safer and cheaper to vary individual factors like pressures and temperatures on a computer model of a system than in the actual process.

Analogues in Design

In the same way analogue computers can also be used to investigate the design of an automatic control system. Previously it used to be necessary to construct scale models. It should be emphasized that it is not a matter of analogue/digital competition, but what a particular job demands. Analogue machines are more suitable for simpler jobs, digital computers with their greater accuracy and flexibility for situations where fairly complex decisions have to be taken.

The more accurate the knowledge of the behaviour of a system, then the better is the quality of control. There is a recent case of a 20 percent increase in plant throughput resulting from thorough analysis of data. And of course the larger the system, the more important a small percentage in the performance efficiency. The effect of each factor and the various adjustments are known and these can be related to economic considerations. A balance may have to be struck between what is technically possible and what is economically desirable. The results have an important bearing on the design of the controlling devices.

Control and Speed

Control, or more specifically ' real time control,' requires that the speed of operation of the controlling device be sufficient to keep up with the rate of change in the process being controlled. An answer must be given in the actual time during which the problem must be solved. It has been pointed out that at 30 m.p.h. a driver can regularly solve most problems in real time, at 100 m.p.h. he will regularly fail some problems in real time.

Whatever the application, the principles of control remain the same. The same computer can be applied to several different processes. It is the input/output devices, the instruments and recorders with their associated electronics, which vary according to the process. There is even greater emphasis on the input/output equipment than with machines for routine data-processing.

In the simple form of control the computer is used for data reduction, providing results from which a human operator is left to decide which course of action to take. Data was received from measuring instruments and transducers (which can convert information on levels, temperatures, etc., into an electrical signal), processed and the results logged. An audible or visual alarm is given when performance is not at the desired value.

In a fully automatic system the computer exercises complete control over a process. There is a closed loop, with the computer receiving information from the plant, calculating alterations and feeding back control signals to carry out these alterations automatically.

Generally speaking, industrial processes require continuous operation over long periods, possibly in arduous conditions, e.g., in unusual temperatures or under vibration. Computers for process control must therefore be very reliable and extremely robust. They must be able to operate without component failure or shutting down for regular preventive maintenance.

Fully automatic process control, after more than 30 years of development towards it, is still in its infancy. There is much development to be done for the creation of complete systems. It involves the co-operation of users, plant and instrument manufacturers. But the use of computers does offer the opportunity of a major break-through in the solution of this problem.

Next: Computers to Design Computers

The object of this DATA DIGEST is to present a selection of the large quantity of material now being published about automatic data processing. For convenience and for the sake of quick reference, the arrangement of items is standardised

REFERENCE

This is given above the abstract, in the following order: Author, Title, Publication

ABSTRACT

This is not intended as a substitute for the original article, which must be read in full for detailed information. The abstract surveys the subject of the original and picks out important and interesting points

GEORGE A W BOEHM

THE NEXT GENERATION OF COMPUTERS

Fortune March 1959 (USA)

The new computers, of elaborate layout and computer-designed, will be from 20 to 100 times faster than today's fastest. They will be expensive. The major development will be the principle of parallel operation and automatic programming.

They will eventually translate languages, notably technical Russian, rapidly and cheaply. Research scientists forecast machines that will imitate human thought and employ judgment.

Manufacturers are already using computers to design the next generation of computers. Remington Rand used a Univac I to design Larc, the Livermore advanced research computer for the University of California. The Pilot computer for the US National Bureau of Standards was designed with calculations produced on an IBM 704.

Very fast computers will employ the Monte Carlo method of representing a very complex phenomenon as a game of chance, with a vast number of repetitions possible in a short time.

Automatic programming will demand its own techniques, including the combination of stock programs for specific jobs.

Language translation will in effect employ a glossary and grammar more detailed than any existing grammars.

The imitation of thought processes is still a

dream, but the difficulties involved in building a machine that acts like a brain at this point seem insurmountable.

R W BREMER

A CHECKLIST OF INTELLIGENCE FOR PROGRAMMING SYSTEMS

Communications of the Association for Computing Machinery March 1959 (USA)

The article is in two parts. Part I is a list of questions for the system designer, under subheadings 'Processor', 'Supervisor', 'Language' and 'Diagnostics'. The purpose is an attempt to begin a systematic classification—to which others are invited to add—of the various devices 'for educating the computer to take over the decision-making functions of one or many human operators', including those already proved feasible and those considered 'highly desirable' for the future. Part II expands and comments on some of the questions in Part I.

D C HENRY and W J KEASE

THE STUDY OF THE APPLICATION OF A COMPUTER TO PRODUCTION CONTROL

The Computer Journal April 1959 (Britain)

The first action in production control routine is to isolate a 'key' processing operation likely to control the rate of manufacture of the product. A second key factor is physical characteristics or limited supply of material.

Basic data will include the time relationships between components of the finished product, involving 'throughput' time, lead times, ordering periods and delivery cycles for materials.

In selecting a suitable computer, input and output facilities, storage, speed, flexibility (versatility) and simplicity are factors to be considered. Simplicity is a most important and often neglected factor.

The production control procedure must be designed so that each portion conforms with its total activities. The effectiveness of the computer is limited by the quality of the data fed into it.

In a proposed system the principal material control records will be kept on magnetic tape. No visible records are maintained but there is access to magnetic tape records at suitable stages.

An integrated series of computer tasks is divided into daily, weekly and monthly operations—product analysis and materials and cost records daily, bills of material and material-feed notes weekly, remittance advices and suppliers' delivery schedules monthly.

The use of computers, initially perhaps adding to the complexity of industry, should ultimately increase our understanding of factories as entities and lead to more effective use of resources.

ELECTRONIC ECONOMY IN A SMALL OFFICE

Management and Business Automation April 1959 (USA)

A computer installed by Automobile Carriers, Inc. in Flint, Michigan, USA, has cut freight billing time by 70 percent. The firm delivers about 300 Buicks daily from factory to dealers. The computer and one operator replace five employees, working considerable overtime, and assorted office machines.

A freight bill for each delivery records date, truck number, trailer number, driver's name, route, consignee, details of cars and freight rate. This information is coded into the computer which, in seconds, prints out freight charges, driver's wages, and other vital data. A daily statistical analysis is also provided.

The computer, a Burroughs Corporation Series E, is the size of a standard office desk. It has magnetic drum store with a capacity of 220 numbers of 12 digits.

EDMOND W MCNAMARA

MAKE YOUR TABULATING DEPARTMENT A SERVICE DEPARTMENT

Computers and Automation March 1959 (USA)

Some reasons why some computer installations in America have failed. The two major reasons are (1) failure to do a sound systems analysis before plunging into electronic mechanisation, and (2) failure to establish a proper operating policy for the data processing function.

A large organisation sought advice on systems analysis in June 1958 for a computer, already selected and ordered, to be installed in December 1958. No feasibility study had been made.

Many computer applications grow out of tabulating jobs. Many existing tabulating departments are ill organised, some overloaded, some too idle. Such operating conditions emphasise the need for an intelligent perspective which will help

to give maximum service in issuing essential reports and analyses on time and at minimum cost.

Control reports for management pose three considerations: (i) the objective of the report, (ii) the content or requirements of the report, and (iii) the cost of preparing and using the report.

The tabulating department providing reports for management should charge departments for services rendered. This would encourage more economical use of services, avoid waste and eliminate unjustifiable demands for superfluous data.

Various Authors
NOVEL APPLICATIONS OF COMPUTERS
Computers and Automation March 1959 (USA)

For Better Beef

The University of Arkansas is using a computer to aid the production of better beef. Statistics of breeding, production efficiency, feeding, physical characteristics of stock, etc will be correlated for use by stockbreeders.

For Contented Students

Purdue University, Indiana, USA, is using a computer to work out the most suitable courses and 'classes' for students at their annual registration. It takes from five seconds to two minutes to work out an ideal time-table in accord with the student's preferences and the university's requirements and facilities.

The Accountant's Claim to Control

The claim of the accountant to be the logical choice as chief adviser and co-ordinator in integrated data processing systems was the theme of a weekend school held at Queen's College, Oxford, from the tenth to the twelfth of April.
We are indebted to the Association of Certified and Corporate Accountants, who organised the school, for kind permission to publish extensive abstracts of the three principal papers read by Associates.

I An Introduction to Electronic Computers

by P A Bundy

Chief Accountant, Atomic Weapons Research Establishment, United Kingdom Atomic Energy Authority.

THE most logical co-ordinator of an electronic data processing system should be the accountant, who has to deal with the largest amount of paper work, such as inventory control, payrolling and billing, in a commercial organisation. He has experience of office routines and mechanised accounting.

The organising of work for a computer provides a challenge to the accountant to reshape his fundamental thinking. Since the development of the computer, every stage of the collection and processing of information has to be carefully planned. One payroll process, for example, involved some 7,000 programme steps.

The accountant will be recognised as the logical organiser of automatic data processing only if he is prepared to go back to fundamental principles and reduce accounting formulæ to the simplest terms.

Management Accounting, a report published in 1950 by the Anglo-American Council on Productivity, recommended that management should make the fullest use of accounting and costing data in forecasting for the future, that it should use standards of performance and accounting control techniques to decentralise responsibility.

Industrial accountants, who should be consulted early in formulating policy, should constantly consider what information is required by management at different levels and should get to know the problems of management and the technical processes in their industries.

Development of Electronic Accounting

For production purposes a mechanical age developed rapidly in the nineteenth century; but the earliest form of mechanised accounting was introduced in Britain only in the latter part of the nineteenth century, a hundred years behind production.

The technique of recording information on a punched card first came into use around 1890. Alphabetical and numerical printing machines did not become available for accounting purposes until the period 1920 to 1930. The production of invoices, stores and cost accounts and the final figures and balance sheet could then be obtained from punched cards.

Accurate and reliable devices using electronics for computing purposes were not developed until the early years of the 1939 to 1945 war, for use with radar and range-finding equipment. Electronic computers for scientific and engineering purposes were thus brought to a high degree of accuracy and reliability, but the commercial application of accounting techniques was not accomplished until more than five years after the war.

The advantages of machine and electronic accounting are the provision of automatic balancing and mathematical proofs, greater legibility, and greater accuracy and speed of posting.

What a Computer Is and Does

The accepted requirements of a computer are to carry out repetitive operations in terms of numbers which are represented inside the machine by electronic impulses. This sequence is called a programme. These attributes are often embodied in the electronic calculator, and it seems more realistic to apply the term 'computer' to an installation where the machine has the capability of modifying a programme by instructions contained inside the programme itself.

A computer can therefore be described as a device which accepts data and instructions at the input, stores them in the storage system, operates on them in the arithmetic unit and produces results at the output, all under the direction of the control unit.

The disparity between input and output speeds and very fast calculating speeds has yet to be resolved. Character recognition will probably lead to a major development of input devices.

The major characteristic of storage devices is a high speed of access. There are four major types of storage. They are based on delay lines, cathode ray tubes similar to those in television sets, magnetic core and magnetic drum.

There can be also external storage devices, to which access is relatively slow. Punched cards are accessible and flexible. Mark sensing of cards means that the original record is ready for processing. The main disadvantage is bulkiness.

Punched paper tape allows the production of information as a by-product of other operations. This information can be sent over teletype lines and fed into a computer.

Magnetic tape has the advantage of big storage capacity—over a million words on a single reel of about 2,400 feet—and the disadvantage of slow access. Magnetic film has similar advantages and disadvantages. Random access stores allow access to any 'address' in the store at the same speed.

Planning a System

Any systems study should be carried out within a general pattern. The first essential in planning an integrated data processing system is the ability to visualise the organisation as a whole. It will be necessary to trace the flow of information from

Members of the Association of Certified and Corporate Accountants who met at Oxford to discuss the role of the accountant in automatic data processing systems. Mr W Jackson, president of the Association, is in the centre of the front row

source to conclusion, to note common usage of data and to determine the requirements of senior management, which management itself frequently does not know.

Transferring Work to the Computer

Under both the old and the new systems accounting principles will remain the same. Any change must therefore pay for itself by savings in staff or in the time of the higher levels of management.

It is very unlikely that the advent of a computer will radically affect the aims of an organisation, but it will alter the internal structure. It will be possible to carry out many additional jobs which previously have been impossible or too expensive.

If the aim is a fully integrated system it will still be possible to transfer self-contained blocks of work on to the computer within a planned framework. Invaluable experience can be gained on such jobs as payrolling or inventory control.

One of the biggest problems of transferring is parallel running. It will be necessary to use the same sources of information for both systems, either by duplicating documents or by using the same documents twice in succession. Either way may cause delay.

Operating the Computer

The operating of the computer may be either 'professional' or 'self-service.' 'Professional' operators will run jobs which have been handed to them as tested programmes. They will not normally be able to correct faults in the programme. If input data is at fault, the machine will stop and the job will be returned to the originator. This could have serious consequences if the job is a payrolling operation.

'Self-service' operators are staff conversant with the original problem who have done the programming. It is not easy to organise an efficient production line operated by numerous 'self-service' operators. The best solution is probably the use of both methods.

Some Problems

Installing a computer raises many problems. The first is obviously the most important—does the organisation really need a computer? It may be necessary to conduct a feasibility study lasting many months or many years. The accountant

L A Hill (left), of Shell Petroleum Company: 'Electronic systems will create problems for the auditors'

P A Bundy (right), Chief Accountant, Atomic Weapons Research Establishment: 'Accountants must go back to fundamental principles'

should assist a systems study team, and play a leading role in it.

The kind and size of computer will depend upon the volume of data to be handled, the storage capacity required, output facilities and, obviously, the amount of money available.

II Feasibility Study—Fundamental Thinking On Integrated Systems

by L A Hill

The Shell Petroleum Co Ltd

A FAIR measure of experience in planning for and operating computers has been gained in Britain and in the United States of America. The mistakes of the past have in most cases stemmed from an under-estimate of the complexities and magnitude of the task. Insufficient time, energy and ability have been devoted to the pre-planning work. Too much attention has been given to the technical specifications of machines and too little thought to the problem of devising new systems, particularly in originating and feeding in data.

Systems are (or should be) evolved to meet designed purposes; only persons connected with a particular business can determine what those purposes are.

The Feasibility Study

It is generally accepted that a feasibility study

should cover three inter-related activities: (a) an examination of existing systems; (b) a study of available machines and equipment; (c) a plan for a feasible system.

These activities should not be discrete sequential steps. It is advisable to plan the study in two stages. The first should assess the possible computer applications throughout the business. The second would normally proceed on the assumption that the result of the first was favourable. There are, however, many benefits to be gained from a thorough investigation into existing systems.

The feasibility study should be carried out by a team reporting to a steering committee drawn from selected heads of departments.

Organisation of the Study Group

A suggested pattern of organisation for the study is one deriving from the board, through the steering committee to a study group headed by a leader and containing sub-groups to examine specific projects. These sub-groups would be directed by a co-ordinating unit within the study group.

The steering committee should be composed of heads of the departments most likely to be affected by the study. Its function should be to guide and encourage the study group and to take decisions on matters of principle. It is absolutely essential that the chief accountant or chief financial officer should be a member of the committee. It will often be an advantage for him to be chairman.

The leader of the study group will act as chairman of the group and will report to the steering committee. He should be familiar with office methods and procedures and understand management requirements. He must have patience and a fervent desire to improve efficiency. An accountant with these qualities should make a good leader.

The group itself should consist partly of O and M personnel and partly of members of interested departments.

Planning a New System

The principles and techniques of methods study should be employed in designing a new system. The study group should have a nucleus of trained methods personnel or, failing these, a trained accountant who can combine perseverance and patience and employ the basic principles of methods study. These are that all clerical work should have a clearly defined objective, that it should be done in the simplest way and should conform to established standards. It should be asked of every unit or function: does it serve a real purpose in attaining an over-all worthwhile objective? If not, then it should, *prima facie*, be eliminated.

Once a purpose is established, the work flow should be tracked back to source, analysed at each stage, simplified and reassembled. This alternation between analysis and synthesis is an indispensable feature of methods work.

Fundamental Thinking on Integrated Systems

The three principles of an integrated system may be stated as:

(I) data should be recorded at or near to its point of origin in a form suitable for machines;

(II) from then on, data should be processed exclusively by mechanical means;

(III) processing of data should be so organised that it serves all subsequent needs.

The recording of original data in machine language is not at present always practicable, but is an ideal to be aimed at. If all relevant data can be captured in machine language at the point where actual physical transactions take place, it should be possible to reduce the human clerical work about any transaction to one operation.

The third principle of an integrated system is the most important—processing of data should be so organised that it serves all subsequent needs.

Forward planning is probably the most important part of any business activity. Its effectiveness depends upon up-to-date information. The computer can assist by working out the probable results of various courses of action, using mathematical techniques.

As control information stems from data initiated by actual transactions, the records should be kept on the same pattern as the plans, so that easy comparison can be made between the two and corrective action taken. An ADP system could be planned to make these comparisons automatically, by feeding both the plan and the results into the computer.

Management needs better information, not more. The information provided by an integrated system should be selective in relation to the needs. In determining the need, the principle of 'management by exception' should be considered. Simply stated, the principle is that merely confirmatory

information is valueless: it is when something is not going according to plan that information becomes vital.

ADP and the Auditor

The introduction of electronic systems will create problems for the auditors. They will undoubtedly have to change their methods because, in an integrated system, no plain language records may exist between the original recordings and the end products.

The Effect on Organisation

A methods study may lead to recommendations for organisational changes. If the organisation is sound it is unlikely that the introduction of any kind of machines would justify a change. In the long run, we may expect to see executive departments becoming progressively smaller. We shall then see empires being voluntarily dismantled and Parkinson's Law going into reverse.

III Electronic Data Processing Applications—Present and Future

by H Shearing

Senior Lecturer in Management and Accountancy Ealing Technical College

THE yardstick which is applied to the introduction of new processes, methods and systems is profitability. From this I deduce two reasons why the accountant should be the adviser and co-ordinator. First, ADP is a new technique requiring a large investment. Second, it will certainly have a decisive effect on the accounting routines in use.

Present Applications

One specialised application of invoicing is of particular interest. A firm of electronic engineers has produced a machine for weighing packed products at the end of a production line. If the packages can be suitably batched to reach the weighing device, then, by connecting this electronically to an electric typewriter in an office, the electric typewriter (if also fed with other information) can be made to produce automatically and without further human intervention the necessary invoices for the customers. This is an example of the kind of thinking necessary to produce truly integrated data processing, the actual operation being made to produce the electrical impulses for direct introduction into electronic systems.

A Swiss air company reports that its entire traffic accounting is performed on electronic data processing equipment. The work includes revenue accounting, passenger ticket sales, excess luggage, freight and the pool accounts necessary where flights involve other airline operators.

In the United States, airline operators are being supplied with punched cards by the manufacturers of spare parts. The operators are asked to punch their orders into the cards, in a form suitable for direct introduction to electronic data processing systems.

The Future

There is no intrinsic value in converting existing methods to automatic data processing systems unless these are going to increase efficiency.

The signposts point clearly in the direction of the accountant as the person to control and co-ordinate efforts. The emphasis will be on more integrated systems, more automatic operation.

Electronic data processing is surely only a subdivision of automation. If this is so, those responsible for it will become less satisfied with the data presented to them from the sphere of technical operations, and will become increasingly interested in why and how this data arises in the first instance.

Managements are at present geared to the limitations in the quantity, quality and timeliness of the information they obtain, on which their decisions are based. Management must be prepared to face the ' mental revolution ' demanded by electronic data processing.

In 1953 there was one digital computer being used for business purposes in Britain. In 1958 the total was approximately 67. It is commonplace to say that automatic data processing needs new thinking. I feel that it demands a new philosophy, a fundamental change in outlook. If the accountant is going to be the advisor and co-ordinator, he should advocate most strongly that the correct approach must be on a firm basis of research.

Books in Braille by Computer

FOR some time mathematicians on both sides of the Atlantic have been working on the problems of language translation by computer. One achievement that demonstrates that translation by machine may be nearer than we imagine is the development by the American Printing House for the Blind and mathematicians from the International Business Machines Corporation of a process for translating printed text into Braille by computer.

Braille is not as complicated a language as Russian, for example, yet writing Braille does require a knowledge of several complicated rules with symbols changing their meaning in different contexts. Basically Braille comprises 63 combinations of six raised dots which represent not only letters, numerals and punctuation marks but also 183 special contractions and abbreviations, analogous to shorthand.

Texts to be translated by computer are first transcribed on to punched cards which are fed into a large computer programmed with a set of rules for conversion of English into Braille.

The computer's translated results are first punched on to cards and from these a printer unit reproduces Braille symbols above the English text for editing purposes. After editing, the corrected punched cards are fed into an embossing machine which produces metal plates for a rotary press. To convert a 300-page book into Braille—a job which would take a skilled translator over six days—only an hour of computer time is required. In addition, however, some time is obviously taken up in transcribing a text on to punched cards.

Adapting Machines

THE experts who addressed the Ergonomics Research Society's 10th anniversary conference in Oxford last month included two specialists from EMI Electronics Ltd.

Ergonomics—the science of adapting machines to suit the men who use them—is sometimes dismissed as a fad to be dumped on a heap with other fads like method study, motivational research and (who knows?) computer feasibility studies. Yet B Shackel of EMI's Psychological Research Laboratory was able to say that the practical value of ergonomic help in the electronic industry is illustrated in the design of control and display details (on oscilloscopes and other instruments) of panel layouts (on a radar set) and on other systems (on computer input devices).

One example of EMI's ergonomic work is that of the Emiac II analogue computer. As a result of considerable study the controls of the prototype Emiac II were considerably modified for the production model.

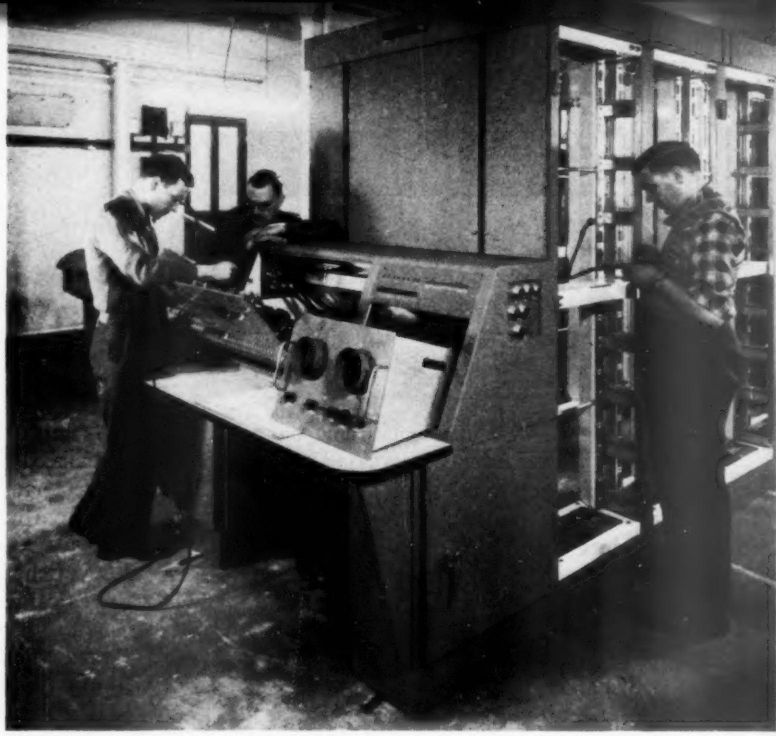
The second EMI speaker, J Arrowsmith, compared conventional and numerically controlled machines from the viewpoint of the operator. Numerical machine tools do not dispense with operators, it was explained, but ease their work and enable them to increase output per hour by removing any responsibility for machining accuracy.

Up-to-the-minute Data Logger for Russia

EQUIPMENT for recording the plant performances of a giant tyre factory which is to be built near Dniepropetrovsk, Russia, by a consortium of British firms has been developed from ideas first published by the British Iron and Steel Research Association (BISRA).

The factory will produce large numbers of differing types of tyres—for cars, lorries, tractors and heavy earth moving equipment. The recording equipment will permit the entire process of tyre and tube manufacture to be monitored hourly and at the conclusion of each shift, providing a complete classified summary of the various components produced.

Recordings will be obtained from 500 different



Andrew Young (centre) will head the Liverpool University team who will be carrying out work on the University's Deuce as soon as the machine has been completely installed and passed the manufacturer's tests. (See **New Installations** *on the opposite page.)*

machines, yet all counting equipment will be centralised, while an adjacent office will be equipped with page printers on which hourly and shift production totals will appear.

Manufactured by the Digital Engineering Company, the monitoring equipment is a development of BISRA equipment originally designed for monitoring the manufacture of certain steel products.

The Viewpoint of Consultants

A RECENT addition to the Management Consultants Association's Blue Brochures series is a pamphlet entitled *Preparing for a Computer*. Though basically literature with a sales message, the pamphlet does raise a number of enlightening points about the computer systems that have been, or will be, installed in Britain.

Clerical cost reduction by computer, the pamphlet states, is the field that has been most tried out; and common applications have been payroll, invoicing and stock control. 'Achievements have varied and although reductions in clerical costs have been secured in some cases, in general the direct savings have been disappointing . . . .' This is a bold statement. Altogether there are in Britain about 50 organisations using computers for business applications (this figure excludes a large number of small, 'plugged programme' computers). The majority of these have put, or are putting, payrolls, invoicing, and stock control, etc., on to their machines, yet few would subscribe to the view that direct savings had been disappointing.

On a second justification for a computer—to provide better and faster information for improved management control—the pamphlet states the scope is far wider though it is hard to assess the cash value of the *earlier* presentation of sales statistics, stock records or cost reports, for example. Nevertheless savings will accrue if the computer can be made to produce the information essential for controlling a business, and this implies 'less but better information' and 'fewer but more significant reports' from the computer.

The third justification for introducing a computer—the opportunity to apply mathematical techniques to solve business problems—'in many cases may prove to be the field in which computers make the greatest contribution to increasing a company's profits.' Operational research, the pamphlet intimates, can show, for example, how less money can be tied up in stocks and work in progress through quicker adjustment of production to changes in sales requirements. The value of a factual solution to this kind of

problem may be very great. On the other hand this kind of problem may occur only once, and operational research techniques do not necessarily require a computer, and when they do it may prove cheaper to hire computer time at a service centre than to install a computer.

One moral to draw from all this is that a computer installation is probably best justified when it can be made to produce the three kinds of results: process clerical work, produce management statistics and produce solutions to business problems—in other words, *integrated data processing*.

New Installations

THE Government Aircraft Factory in Melbourne, Australia, has ordered an Emiac II analogue computer. The contract is for a two-module machine.

A very much larger Emiac II installation has been ordered by the Sir W G Armstrong Whitworth Aircraft Company Ltd. This, when it begins to operate in July, will be one of the most powerful analogue machines in Britain. It will be used to solve research problems of rocketry and high-speed flights.

The University of Liverpool has installed an English Electric Deuce Mark 1 computer in the Ashton Hall Mathematical Laboratories. The installation will enable the laboratories to expand, very considerably, the services they offer to university departments, such as the nuclear physics and oceanography department, and to outside organisations. Computer time will also be hired to local industry.

The University is proud of the fact that a large part of the cost of installation has already been received from private donors and organisations in response to an appeal.

The computer will be used to extend the laboratories' work on numerical analysis. Calculations that previously may have taken many months to complete, or which were for practical purposes unmanageable, owing to the sheer physical demand on the mathematicians available, may be dealt with in a matter of days or even hours.

Typical problems to be dealt with will be the calculation of results of experiments on the nuclear physics departments's synchro-cyclotron, and the study of the effects of sub-surface currents in the Irish Channel. General work will also include calculations for the Aeronautical Research Council of the Ministry of Supply, calculations of the stresses in building structures and the analysis of astronomical observations of the variation of latitude due to the earth's rotation.

The computer will be equipped with seven-hole paper tape input and output and a 64-column punched card system.

Expansion in Europe

THE purchase of a 110,000 square-foot factory at Villers-Ecalles, near Rouen, France, by the Burroughs Corporation marks the company's decision to expand its production capacity in Europe. The factory, due to begin operations on July 1, will initially employ some 600 people in the manufacture and assembly of 10-key adding machines. Burroughs already operate two factories in France, at Pantin and Romainville, where adding and accounting machines and electronic equipment are manufactured.

The JUNE issue of

AUTOMATIC DATA PROCESSING

will contain

Planning and Installing an Integrated System

by Clinton Robinson

Economics and Computers

by Harold Shearing

and detailed accounts of the computer experience of a large retailing organisation and an aircraft company

Letters to the Editor

Unfair to Computers ?

The Editor

AUTOMATIC DATA PROCESSING

Sir:

A comprehensive survey of the whole field of digital computing is an extremely difficult undertaking and Dr Booth made a brave attempt at this in the March issue of your journal.

One feels, however, that he has done less than justice to some aspects of digital computers, particularly in this country. It is not true, to my mind, that the electrostatic store 'never appeared a particularly promising contender in the field of storage'. It did, and several extremely successful machines were built using it on both sides of the Atlantic. The Manchester University machine whence Mercury is derived was built around an electrostatic store. Notable advantages over acoustic delay stores are its independence of temperature variations and immediate access. Its disadvantages are the fact that it is a thermionic device and it is not suitable for parallel access (despite the TRE and Manchester machines). Ferrite stores superseded it on grounds of size, no long term deterioration of characteristics, and the fact that one has a fast-access permanent store, i.e. it requires no power to retain information.

Likewise the statement that British machines use hot cathode techniques whilst Americans are 'veering towards all transistor construction'. In fact events on this side of the Atlantic show that manufacturers have always had an eye on transistor machines and the only limitation has been that up until now there have been no transistors!

Pioneer work on transistor machines was done at Manchester University (resulting in the Metrovick Computers now on the market) and AERE Harwell (CADET).

Ferranti Limited have a transistor computer built from Neurons, and Emidec 1100 and 2400 are two extremely powerful machines in production. I believe there is also a Hollerith transistor machine. The transistor is here as a computing device and the thermionic valve is finished. (Is anyone building a new computer using thermionic valves?)

In fact the tenor of papers at the recent IEE convention on new digital computer techniques showed that skeletons of third generation machines are all based on transistors.

Yours faithfully,

D S WILDE

[Dr. Booth comments:

'As readers must have appreciated, my two articles on the future of digital computing machines were intended to be controversial and indeed contained a number of points upon which I can quite sincerely express precisely the opposite opinion to that which I gave.

However, having learnt the opinion of Mr Wilde in his letter, I do not find the least cause for recantation, particularly in his assertions regarding third generation machines. In recounting ancient history one can, of course, only relate what one felt at the time, but I think that in the particular case which Mr Wilde quotes, the proof of the pudding has been in the eating, and time has confirmed my opinion.'—Editor, *Automatic Data Processing*.]

ICT Punched Cards

The Editor

AUTOMATIC DATA PROCESSING

Sir:

In the March issue of your journal you were kind enough to make reference, under 'Names and Notes,' to the merging of The British Tabulating Machine Company Limited and Powers-Samas Accounting Machines Limited, which resulted in the formation of International Computers and Tabulators Limited.

Unfortunately, you included a reference to the products of the new company which may be misleading. This stated that 'it has been agreed to standardise on an 80-column card'.

This is only partially true as it does not affect the production of equipment for use with cards of 21, 40 and 160 columns capacity, all of which are being continued. In fact the application of the 21-column equipment is being widened now by the introduction of a summary card punch which has not hitherto been available in this range.

Yours faithfully,

A A McPHIE

International Computers and Tabulators Ltd

Imput and output speeds, file capacity, costs and reliability are all . . . .

Factors in Choosing a Computer

by J G THOMPSON
BOOTS PURE DRUG CO LTD

NOT so long ago the electronic computer was the plaything of the scientist and a mystery to everyone else. When the rumours began to spread that computers were invading the world of accountancy and management, many a manager sat back and laughed and said: 'These so-called electronic brains will never do my job.' Basically he was probably right, in that the computer cannot manage—it cannot think for itself. But many did not realise how much routine clerical work could be taken over by a computer, or, as it is more properly termed from a business point of view, an automatic data processing system. Moreover, it is now becoming clear that such a system can be a powerful tool to help management to carry out its job more efficiently.

These two ideas should be kept in mind when thinking of ADP systems—the possibilities of abolishing much routine clerical drudgery, and the prospect not only of obtaining management information quickly, but of obtaining just the information required; not a mass of paperwork over which someone must pore for many hours to sort the wheat from the chaff.

But how is it possible, amidst the bewildering variety of glossy machinery put before us in glossy brochures, to see what sort of system might be suitable for a particular type of job?

Perhaps this article can give one or two pointers to help compare one system with another.

The ADP System

First, a picture of the data processing system as a whole.

There are five main units—*input, output, storage, arithmetic* and *control*.

Think of these in relation to a clerk writing an invoice from a customer's order.

The details on the order are the *input* into the process.

When the customer's name, the item description, the quantity and price are copied on to the invoice form, *storage* takes place—the information is stored until the amount due has been calculated.

The clerk's *arithmetic unit* may be a ready reckoner, a desk calculator, or a nimble brain which can cope with mental arithmetic.

The *output* of the process is the completed invoice for despatch.

The *control unit* is, of course, the clerk, controlling each stage of the operation according to a list of instructions either written down or memorised.

Now to consider some of these units in a little more detail.

Punched Card Input

The majority of computers in use today have input on punched cards.

This is not just because the majority of the firms who made the computers also sell punched card accounting machines.

In point of fact, the punched card is a very convenient form of input for several reasons.

1. It can be produced by machines which have been thoroughly tried in practice over many years, either by manual punching, automatically from pencil marks, or at a distance by data transmission devices.

When considering mediums and systems for input, output and filing, the needs of the company rather than the features of the equipment must be the yardstick for assessing usefulness. (Above: an IBM 650 with four tape units.)

2. It is easily checked, again by well-tried machines, and checking of the accuracy of input is of paramount importance when an unthinking machine is to be responsible for processing the information on the card.
3. In many applications the card can be used for other purposes before and after the computer uses it.
4. In a well-designed system, it can be well packed with information and provide input at high speed.
5. Punched cards can be rapidly sorted into sequence on a high-speed sorting machine. The presentation of input in a fixed sequence can often speed a computer job very considerably, for the sorting of data is not a job at which the general purpose computer excels.
6. Many clerical jobs are already being carried out by punched card accounting machinery. In these cases the changeover to an ADP system may be carried out more easily, quickly, and economically (especially if the old equipment is due for replacement).

Paper Tape

One of the competitors of the punched card now becoming more popular as direct computer input is punched tape. This has been in use for many years as input to communication systems, so why not to a computer system also?

1. It is very cheap and economical in use. The whole length of the tape can be filled with data punched at 10 characters to the inch whereas the normal punched card can only use a maximum of one-twelfth of its area, with one punched hole in each column, or one-sixth when filled with alphabetical information.
2. A large quantity of data can be filed on one small reel of tape.
3. Tape can conveniently be produced as a by-product of already necessary operations such as typing, add-listing, and cash register operation.
4. Machines are now available for checking the accuracy of manual tape punching, using the same principles as punched card machines.
5. Automatic checking can now be incorporated in the creation of punched tape, at a distance over teleprinter lines.

Magnetic Tape

To complete the input picture, there is magnetic tape. Everyone is familiar with the use of magnetic tape for the recording of speech and music. In computer applications, the principle of recording is the same, but a magnetic spot is recorded on the tape instead of punching a hole, as on punched paper tape.

Machines are already available in the USA, though not yet in Britain, for producing magnetic tape from a typewriter and printing the data in clear at the same time. Visual checking is therefore possible, though it is generally agreed that an automatic checking system, such as those used with punched cards, would give greater accuracy.

Information can be packed on magnetic tape at 100 or even 200 digits to the inch, compared with 10 digits in punched tape. At this density a 100,000-word novel could be recorded on one reel of magnetic tape. The speed of movement of the

tape is often such that, if full speed could be maintained, a computer could 'read' the novel in about six minutes. This idea is not as crazy as it sounds. The Americans have already transcribed the Bible onto magnetic tape, and a computer has been reading the tape and writing a new Concordance, a job which took the author of the original Concordance 30 years to complete.

Input Speeds

One of the first tasks when selecting an ADP system is to consider the relative speeds of input of these machines, from the office point of view.

The rates of input quoted in the various specifications published from time to time are usually maxima. This enables direct comparisons to be made with speeds of similar equipment. Practical operating speeds may be much slower for a variety of reasons.

Take punched cards for instance. A typical speed is 150 cards per minute. If there are 80 columns on the card, this represents a speed of 8,000 columns per minute and each column can contain a hole or holes representing a figure or letter. But first of all one must check that the computer which will read the card can read all of it. Some computers can only accept information from less than half of the card. Then it is necessary to consider how much information can be packed on to the card in the particular application being considered.

If each unit of data takes a maximum of 10 digits, an 80-column card can hold eight units. But many units may consist of much less than 10 digits and if units must be sorted into sequence, it may be necessary to use one card per unit.

So the actual rate of input of data may be far less than the quoted figures, either because the data fields are not fully utilised or because sorting requirements have limited the usage of card space. An allowance must also be made for loading and unloading the card hoppers and clearing an occasional 'wreck' when a damaged card jams a feed mechanism.

Interrupted Operations

Punched tape, too, has its limitations. We read of high-speed tape units coping with 300 or even 1,000 characters per second, which means shifting the paper at up to 500 feet per minute. The mechanisms moving the paper and reading the codes can no doubt cope with this speed; but in practice, when reading the data on the tape, it is often necessary to halt the tape momentarily, whenever a certain quantity of information has been read, owing to a limitation of some other part of the system such as the revolution time of a magnetic drum or the speed of a tape punch. Moreover, on five-channel tape, which is normally used in Britain, it is necessary to insert a code whenever changing from figures to letters and vice versa, and another code to mark the end of each unit of data. These additional codes must all be read, so that the effective reading speed may be far less than the maximum, especially if input is on many short lengths of tape, and only one reader is available.

On magnetic tape similar conditions often apply. In some systems it is necessary to record two numbers to represent one letter.

The stoppage which is necessary in many practical applications, after reading each block of information, assumes even greater importance on magnetic tape, since it may be quite long compared with the time taken to read the block.

The speed of movement is so great—in some cases up to 200 inches per second—that space must be allowed between blocks of information, so that, after the tape has stopped at the end of one block, it can be accelerated to full speed before reading the next block.

A typical time to stop and start a tape is 1/150th of a second. This sounds negligible but during that time the computer could read 100 digits from the tape, if the reading speed is 15,000 digits per second, which is not uncommon. So the effective speed of magnetic tape reading will again depend on the type of information to be read, the number of blocks into which it is divided, and the speed with which the other units of the system can deal with the data.

Finally, with all types of input, the effective speed may be reduced by the ability of the computer, in the particular job to which it is being applied, to cope with the information as fast as it can be fed in. Modern techniques of input circuitry are aimed at minimising or eliminating this cause of delay.

Output Speeds

As with input, punched cards are very frequently used in the output unit. But here again the quoted speeds of 100 to 120 cards per minute must be considered in relation to the amount of information actually being punched onto the card in a particular job.

Many machines can punch tape as output at

from seven to 60 characters per second, and, since the tape is more fully used than the card, this may prove more economical. The latest tape punch, displayed at Olympia last year, can punch 300 characters per second. At this speed tape loading time becomes significant, since the machine can gobble up a roll of tape 1,000 feet long in less than seven minutes. An important factor, however, is how much of the output must be in legible form.

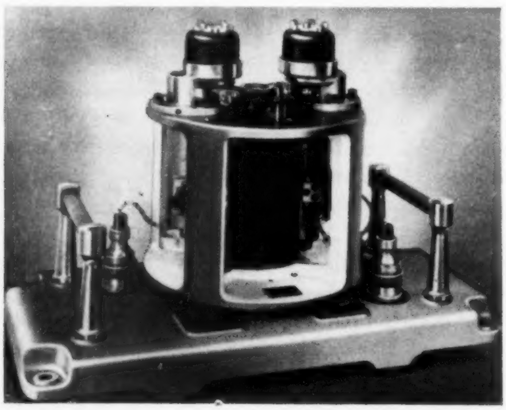
If a great deal of output is required to be printed from the punched card or tape, we must match up the cost of a highly developed punched card printer or tabulator against a battery of much slower machines for translating punched tape into print.

We can see punched cards producing from 80 to 300 or more lines of print a minute. Here again the effective speed depends on how many characters are printed on each line. Speeds quoted in characters per minute or second often assume continuous operation at full speed with a character printed in every position on every line.

The tabulator can add to the effectiveness of the operation by adding and subtracting as printing proceeds and producing totals which can be printed and punched into summary cards simultaneously if desired.

Punched tape is for simpler applications, where printing only is required, and the speed of printing is limited to seven to 25 characters or spaces per second. These methods of output are called off-line methods.

It is possible, as an ' on-line ' method of output, to connect a printer direct to the computer. Many computers now in use are designed like this. The advantage is that output is immediately available in clear and equipment requirements are smaller. Against this must be weighed the possibility of having to slow down the computer, which can usually process data much faster than a printer can print the results, and having to stop operations completely if the printer breaks down.



A general rule: the faster a store can accept and release information the more it will cost. Above: an English Electric drum store.

Magnetic tape provides the fastest output of all, with a maximum speed of up to 60,000 characters a second. But converting this into print involves extremely expensive machinery if it is to be carried out at high speed as an ' off line ' operation.

Xerographic Printing

It seems possible that the problem of matching speed of output to computer speed may be solved by recent developments in continuous xerographic printing. Speeds of many thousands of characters per second appear to be within reach with very few moving parts and therefore a high degree of potential reliability.

Here are some of the factors to be considered when deciding on the type of output required:

1. What is the minimum amount of output to satisfy the requirements of the job? Is it necessary to print out something for every item processed, or can the computer be programmed to print out *only* those items which require attention? This principle of management by exception is becoming a more practical proposition with the help of electronic data processing.
2. Having regard to the time taken by the computer to process data, will a directly connected printer be able to accept data fast enough to enable the computer to work at full speed?
3. If a favoured computer has output on punched tape and this must be translated into print, is the speed of a tape-operated typewriter or teleprinter sufficient to cope with the output, or can the data be conveniently broken down into sections for printing out on several machines?
4. If off-line output is considered desirable, will tape editing (to produce presentable copy in the form required) slow down output speed, or can it be carried out by the printer itself?

Internal Storage

The term ' automatic ' applied to a computer means that it is capable of carrying out long series of operations automatically and without human intervention.

In order to do this economically, it is usually

necessary to store much information, both inside the computer and externally. The internal stores of the computer are used to hold the programme of instructions to control the processing, and any constants or tables which may be needed, and to store each unit of input as it is being processed and each unit of output prior to its conversion into punched cards, tape or printed form.

The size and type of internal storage required must depend very much on the applications in mind, but a general rule is that the faster a store can accept and deliver data from and to the various units of the computer, the more expensive it will be. So a compromise must be made between cost and accessibility of information in the store, a factor which may have a profound effect on the processing time.

External Storage

External storage may be on punched cards, punched tape or magnetic tape.

Such items as carry forward totals in wages application or daily stock levels can be conveniently stored on cards, automatically punched out during processing, as with a conventional punched card system.

With a large inventory or payroll, however, and high daily activity, the cost of repunching cards every day may be very high. Magnetic tape may then prove economical, since it can be used over and over again.

It should be remembered that if data is to be stored for any length of time, magnetic tape, although it cannot be read directly, stores a lot of information in a small space. A 10-inch reel may hold as much data as 20,000 to 30,000 fully punched cards. The U S authorities have now agreed to accept magnetic tape records for tax purposes in place of written documents (no doubt with a proviso that the tape must be written in a code which their computer can read). At the moment there is no common code used for magnetic tape recording and, except between machines produced by the same manufacturer, one computer cannot process a tape produced by another computer.

Random Access

The enormous storage capacity of tape has its drawbacks. If the information on it is required in random sequence, the computer will spend most of its time running the tape through to find particular items.

It is for such jobs, requiring the facility of access to a large quantity of information, that random access machines have been designed, and a few 'file processing' devices which, with magnetic tape input and output, will carry out at high speed the jobs which are handled, in a punched card system, by sorting, merging and selecting machines.

It is certainly an attractive idea to be able to ascertain up-to-date information as and when required, and many airlines are already using this principle for booking flights, giving each agent the facility of obtaining up-to-the-minute information of available seats direct from a computer store.

It is for the customer to decide whether a random access store is justified or if it is more economical to process information in batches sorted into sequence, and put up with a longer delay when an enquiry must be settled urgently.

These are a few of the factors influencing the suitability of a particular automatic data processing system for a particular job. But it must be stressed that the initial selection is only a beginning. A great deal of hard work is necessary, afterwards, before the final instructions can be worked out and translated into a 'programme' which will tell the computer what to do in every possible contingency.

The modern teleprinter will punch and 'read' tape as well as produce a printed page. Messages can be sent manually or automatically

How Paper Tape meets Computer Demands

by **DAVID BARKER, MIAMA**
CREED AND COMPANY LIMITED

Equipment and techniques long known and used in telegraphic communications are finding enthusiastic and widespread acceptance in today's fast-developing automatic data processing systems.
Through the medium of punched paper tape, operational compatibility is being achieved between business machines of many kinds. As a result, data vital to efficient, modern management and control are being interchanged and automatically processed on a scale never before accomplished and with new standards of speed, accuracy and economy.

TEN years ago punched paper tape was practically unknown outside the communications field. Even there it was limited to a comparatively small number of highly specialised telegraph machines. Today punched tape is basic to ADP procedures of many kinds and the number of machines capable of handling it grows larger all the time. How has this revolution come about?

Punched tape as we know it today was originated by telegraph engineers in the twenties, seeking means to improve the efficiency of sending telegraph messages. At that time all traffic was sent straight to line from the keyboard of the teleprinter, and the speed of transmission was therefore directly related to the speed of the sending operator, within the physical limits of the equipment itself.

Where continuous sending was to be maintained over any appreciable length of time, limiting factors, such as interruptions and fatigue,

resulted in an average speed of transmission well below the maximum of which the equipment was technically capable.

Means were accordingly sought whereby transmission could be accomplished continuously at maximum equipment speed, not only to reduce the sending time but also to effect savings in cost by virtue of the better utilisation of expensive circuit facilities.

Punched tape proved the answer to the problem. Instead of the message being transmitted direct to line, it was first recorded 'off-line' in punched tape form. Since no circuit facilities were involved in this operation the speed at which the message was punched was relatively unimportant. The tape was then fed into an automatic transmitter connected to the telegraph line, and signals corresponding to the code perforations in the tape were despatched over the circuit at top speed. This arrangement made for much higher over-all speed, improved efficiency and made possible important operating economies.

As a result, punched tape rapidly became established in the telegraph field, and is now an everyday tool in communications systems.

Application to ADP

Almost 30 years were to elapse before the potentials of punched tape were appreciated outside the communications field. Credit for 'discovering' punched tape for ADP purposes probably goes to the computer engineer. Shortly after the last war, when the first electronic digital computers were taking shape in the laboratory, computer designers began to investigate teleprinter equipment as a possible means of providing essential input and output devices for feeding 'raw' data into the computer and recording the processed output.

Telegraphic communication requirements had demanded the development of a broad range of equipment characterised by its high speed of operation, reliability, and flexibility of construction. Also by virtue of large scale production, moderate cost was a marked feature throughout the whole range of machines.

Since these same features were required in large measure in data processing systems, it was not altogether surprising that computer engineers soon began to incorporate teleprinters and punched tape equipment into their initial systems.

Even at that early stage, however, the use of teleprinters and punched tape equipment was generally looked upon as a temporary expedient, as it was considered that important facilities would be required later which could not be achieved with such machines. This has not proved to be the case, however, and although other equipment is available for input and output purposes, the opinion is now generally held that punched tape is here to stay in numerous aspects of ADP work.

Coding Method

Punched tape in general use at the present time is nothing more than a strip of paper 11/16 of an inch wide and a few thousandths of an inch in thickness. It can be any length, but for convenience of handling it is usually supplied in 1,000-foot reels. On this raw material data are coded by means of one or more holes punched in any of five invisible tracks along its length. Successive combinations of code holes are punched one after the other, together with smaller feed holes which enable the tape to be advanced by a sprocket wheel.

In five-track tape there are two-to-the-fifth-power (2^5) or 32 coding possibilities, depending on whether each of the five holes is punched or not. These 32 combinations are sufficient to cover the normal English alphabet and, with the aid of a 'shift' arrangement, are extended to cover

Data for a computer have to be 100 percent accurate so input tapes need first to be verified. Below, an original tape (on the left) is compared with keyboard entries being made from the source document. The machine compares the holes already punched in the first tape and produces a second, error-free tape (on the right)

the 10 decimal numbers, ordinary punctuation signs and special codes for machine operations. The method of allocating these combinations to various items of intelligence has been decided by international agreement for telegraphic communication, but no such standard exists in the ADP field. In general, therefore, the coding method adopted is largely determined by the particular applications for which the tape is required. This ability to meet the specialised coding requirements of the ADP field is another factor in the widespread acceptance of the equipment.

Whilst five-track tape is the international standard for telegraphic communication purposes, and is likely to remain so, for ADP operations the need for tape having a greater information-carrying capacity is being experienced. Each additional code track doubles the capacity of the tape and this has led to the introduction of paper tape $\frac{7}{8}$ of an inch wide, having six- and seven-code tracks providing 64 and 128 combinations respectively, and one-inch-wide tape with eight tracks giving 256 coding possibilities. This is expected to be adequate for all present and foreseeable coding requirements in data processing.

Inherent Advantages

Although other media are available to the ADP user and the choice will again be determined by the application, punched tape has a number of inherent advantages, not the least of which are its low cost and ready availability. Tape to accommodate one million code combinations costs less than thirty shillings and it can be delivered in quantity from numerous suppliers. From an operational viewpoint, the positive, visible nature of the recorded data and the ease with which correction and editing can be accomplished, are important factors, as is the continuous nature of the record, which obviates the possibility of data inadvertently getting out of proper sequence. Paper tape also offers a satisfactory data capacity/volume ratio and is largely unaffected by environmental conditions. Perhaps the most important advantage of all, however, is the fact that it is, of itself, a communications medium.

No ADP programme involving distant or widespread locations can be completely efficient and successful without a communications system for the instant, accurate interchange of 'raw' or processed data. The teleprinter already meets this requirement and since it operates with punched tape it follows that tape is a logical medium on which to base ADP operations, since data recorded in tape form can be transmitted almost anywhere in the world by telegraphic communications facilities, without further processing.

Preparation of Data

Source documents and data can be converted into punched tape form in any of several ways. One of the most economical is by means of a keyboard perforator. The operator reads the source document and, by depressing the keys of the keyboard, converts the source data into code-punched paper tape. The operator's primary concern is to depress the proper keys in correct sequence, and as the machine provides no printed guide copy of the data thus coded, accuracy in keyboarding is essential.

Whilst this method is satisfactory for the preparation of short lengths of tape, such as brief amendments to computer programmes, it is desirable, for the production of more complex and lengthier tapes, to employ equipment which provides the operator with a printed record copy of the data encoded in the tape.

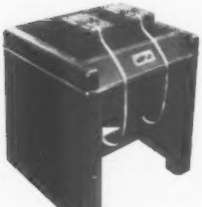
This is achieved by a teleprinter equipped with a tape punch attachment which provides a punched tape of all entries made on the keyboard, with simultaneous by-product printed-page copies for proof-reading, distribution and record purposes.

Once a quantity of data has been recorded in tape it normally need never again be manually retyped since the tape can readily be reeled up for storage and re-use as required. Punched tape is thus an automatically reproducible or self-perpetuating storage medium by means of which repetitive data can be reproduced whenever needed. Moreover, as already noted, data can at any time be added to or deleted from existing tapes to produce new tape coded records.

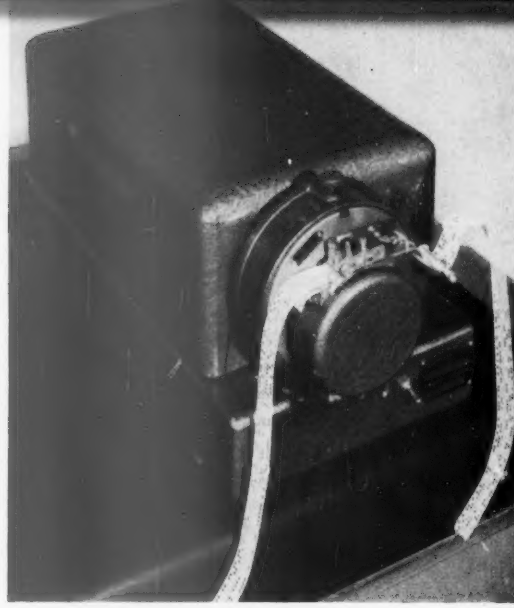
Master or constant records can also be maintained on edge-punched unit record cards which in certain cases have advantages from a filing standpoint. Usually made of manila and some seven inches by three inches in size, these cards carry coded data punched along one edge. Constant data code-filed in the card can readily be converted into punched tape and integrated with new, variable data to produce composite tapes.

Linked Machines

Data may also be captured in punched tape form by means of tape punches linked to otherwise standard office machines. For example, an



Two supposedly identical paper tapes can be matched up on this 'comparator.' The machine stops and gives an alarm when the tapes show disagreement



The output of a tape-fed teleprinter can be on continuous stationery, controlled as shown (above left) by a Formaliner. A tape reader and transmitter (above right) could transmit data, in conventional or binary code, from a district office to a central data processing centre

accounting or adding machine can be linked to a punch which will produce tape as a by-product of their primary function. Or a cash register may be similarly hooked-up to a punch so that in addition to producing itemised sales receipts in the usual way, such entries are also automatically recorded in a continuous punched tape. This tape can then be sent to a central accounting department either on the premises, or if at a remote point, *via* a telegraphic communications link, where it becomes the basis for automatic machine processing by computer or punched card equipment.

It is of interest that the border line between business data processing and industrial process control is a very narrow one in terms of equipment and principles, particularly in the case of the punched tape technique.

Thus the code perforations in the tape may be used not only to record data, but also to control processes by using the coding to represent instructions.

A good example of this is provided in the automatic control of machine tools by means of punched tape. In this case dimensional data compiled in the drawing office are coded into the tape which activates servo-controls on the machine to produce the required part automatically. Complicated profiles may be cut in one operation and savings as great as 80 percent of machine time are achieved by comparison with manual operation. The sequence of operations of many machines can be controlled automatically in this way.

Other examples of the industrial use of punched tape are to be found in conveyor systems, with automatic routing taking place in accordance with pre-determined programmes punched in the tape. Punched tape is also being successfully used to control wind tunnel operation, the shape of the tunnel being altered by tape-controlled hydraulic rams to vary the speed and character of the air currents passing through it.

Although the application of punched tape to industrial control is still at an early stage of development, there is little doubt that it will eventually play an important part in bringing practical realisation to the ideal of automation.

Tape Editing

Obviously, if incorrect information is furnished to a computer it will produce a flow of wrong answers. A well-known computer manufacturer has estimated that in a manually prepared unchecked tape one operator error may be expected to occur in every 300 to 2,000 characters punched.

Some errors are noticed at the moment of punching and these can be corrected without difficulty straight away. Other errors are not so easily dealt with and at one time the punched tape system was at a disadvantage in this respect. Now, however, equipment has been developed and is in production which enables errors to be detected and eliminated with speed and accuracy.

One such method is by the use of a keyboard

tape verifier. This machine consists of a keyboard, tape reader and tape punch, interconnected electrically. The initial tape, produced by any of the various methods already described, is placed in the tape reader and verified by typing out the original source data, this time on the verifier keyboard. The interconnection of the keyboard, tape reader and tape punch is such that if the combination typed corresponds to that sensed by the reader, this same combination is signalled to the punch. If they disagree the key is locked down and the punch will not operate. Inspection then determines whether the error is in the original tape or in the typing operation on the verifier keyboard. Appropriate action is taken according to the location of the error and the punch released, the result being a perfect tape which does not reflect errors detected either in the original tape or in the operation of the verifier keyboard.

Frequently it is necessary to be able to check two supposedly identical tapes, one or both of which have been produced as a result of automatic operation. In such cases other means of checking are available, involving the use of tape comparators.

One simple method involves the use of a tape comparator in which two supposedly identical tapes are read in synchronism at high speed until a discrepancy is detected, when feed is halted and a visual or audible alarm given. After noting the discrepancies the operator restarts the comparator which proceeds automatically until the next disagreement or the ends of the tapes are reached. A more sophisticated version of the comparator is also available in which the two tapes are compared as before, and a third 'clean' tape produced, containing only correct data derived from the two original tapes. If desired, a page print can be provided of the third tape.

Correction of tapes is probably the most important function of tape editing equipment, but it is also extensively used for copying tapes, and producing composite tapes, i.e. tapes containing data derived from two or more other tapes.

Tape Reading and Data Transmission

Having prepared our punched tape and edited or corrected it as may be necessary, the next stage is to feed the coded data into the electronic processing equipment. If the latter is at a distant location the tape coded data can be conveyed to it by messenger, mail or telegraph. Assuming the data are to be transmitted telegraphically to a distant processing centre, the tape is fed into a standard telegraph transmitter (reader) with no further processing. The reader automatically converts the code perforated data into a train of appropriate electrical signals which it transmits over the connecting circuit at the international telegraph speed of 66 words per minute. At the distant point the incoming signals are automatically converted back into a punched tape identical with that used for transmission at the sending point. If required, a simultaneous page print-out can be also obtained at the receiving point to provide a check on the contents of the tape.

At the present time the GPO cannot guarantee that circuits will not be subject to extraneous interruptions or interference. Interruptions to transmission long enough to eliminate large sections of the data being transmitted are infrequent; interference of very brief duration which might cause the loss of occasional bits is more likely to be encountered. This problem is under active study, but already techniques for error-detection and ensuring accuracy in transmission have been devised and suffice in certain situations. Double transmission of data with automatic comparison at the receiving point is one such method, whilst the use of checking codes is another which is being used with success.

If the tape coded data are not first required to be conveyed to a distant point, tape can be fed direct into the computer. For such operations maximum input speed is desirable and this has led to the development of the photo-electric type of reader which is capable of speeds far in excess of those obtainable with the electro-mechanical readers used in telegraph systems. Numerous photo-electric readers are commercially available and speeds in excess of 1,000 characters per second are already being achieved.

Output Recording of Data

Turning now to the output side, equipment is necessary to convert the electrical signals emanating from the data processing equipment into a form which can be read by the human eye.

It is probably in the field of output recording that the biggest problems have been encountered —and the most spectacular results achieved.

Speed of output recording is all-important in computer working. Until the computer is able to clear one set of calculations it cannot take on fresh work, which means quite simply that costly equipment is not being economically utilised.

Output data can be converted into printed copy direct with a relatively small capital outlay by employing automatic printing devices such as teleprinters or solenoid-operated electric typewriters, connected on-line to the computer. The speed of operation of such equipment—seven to 10 characters per second—leaves much to be desired in the case of most computer installations, but the alternative of high speed line-at-a-time printers frequently does not prove attractive from an economic standpoint.

Clearly a more satisfactory speed/cost ratio had to be found and here again punched tape equipment provided, and continues to provide, a very acceptable answer to this requirement. So much so that most of Britain's leading electronic digital computers use punched tape almost exclusively for output recording.

Originally results were fed out on to punched tape at a speed of some 15 characters per second, about double normal teleprinter speeds. Further development led to another two-fold advance in punching speeds and at the present time most British computers using punched tape as an output medium deliver results at a speed of some 25 to 30 characters per second, using a tape punch costing around £200.

Whilst this speed is acceptable for some applications, for others it still falls considerably short of requirements.

Now, however, a quite spectacular advance has been made and a tape punch is in commercial production in this country which is designed for direct on-line operation at the remarkable speed of 300 characters per second (3,000 words per minute). At this speed a full standard size reel of paper tape with a capacity of over 120,000 characters is punched in less than seven minutes. This is more than 10 times the speed of the output punches at present in general service and more than 40 times faster than a normal teleprinter. Moreover, whereas earlier output punches were limited to five-track tape, this new machine is capable of recording on five-, six-, seven- or eight-track tape with equal facility and speed.

Finally, having recorded the output of the computer directly into punched tape form, it is normally necessary to convert this data into printed plain language copy. This operation is performed off-line, i.e. independently of the computer. It can be done on the spot or, alternatively, the output tape may initially be used to transmit the recorded data telegraphically to some remote point for interpretation.

In either event, since interpretation of the tape coded data does not involve the computer itself, the need for speed is not so great as for the initial direct on-line recording operation. Consequently at the present time the standard teleprinter is commonly used to produce page print-outs of the tape, a battery of such machines being employed if necessary. The teleprinter, being designed for continuous heavy-duty operation, has proved a reliable yet moderately priced piece of equipment for such work. It also offers a useful degree of operational flexibility as exemplified by an ability to handle multi-copy pre-printed business forms and duplicating masters as well as plain paper rolls. The teleprinter can also be programmed to perform the functions of carriage return and line feed automatically, where these are not provided for in the output tape.

Faster printing would naturally be desirable in the interests of over-all efficiency, particularly in view of the important step forward in tape-punching speeds already mentioned.

At the present time a considerable gap exists between the relatively inexpensive but slow serial output printers and the very fast but expensive line printers.

To meet this situation a medium-speed, medium-cost character-by-character (serial) output printer is now in an advanced stage of development in Britain.

This machine is designed to operate at a speed of 100 characters per second (1,000 words per minute) i.e. 15 times faster than normal teleprinter speeds. Although it will probably be used mainly as an off-line print-out device for the high-speed tape punch, its speed of operation is such that in many situations it will prove fast enough for direct on-line recording. This is particularly so in the case of the smaller types of computer which do not justify the high speed and cost of line printers but can nevertheless utilise faster output printing than is possible with present teleprinter equipment.

Though this has been only a general outline of developments in the punched tape field, it does show the significant strides which have already been made in a few short years in its application to ADP problems and requirements. It is also evident that the manufacturers, encouraged by the widespread acceptance of their existing equipment, are actively engaged in research and development on a scale which will ensure continued progress in the service of ADP with its almost unlimited possibilities in the years ahead.

At the Business Efficiency Exhibition

THE Business Efficiency Exhibition will be at Olympia from 25 May to 4 June. Among the exhibitors will be a number showing data processing equipment of various kinds. This survey gives details of some of the more interesting exhibits, but it is not claimed to be comprehensive. Full information can be had from the organisers of the exhibition, the Office Appliance and Business Equipment Trades Association, 11 Dowgate Hill, London EC4.

INTEGRATED DATA PROCESSING

During the past few months two new models of the Friden Flexowriter have been announced by Bulmers (Calculators) Ltd. All models of the machine are basically the same, consisting of a paper tape reader, a heavy-duty automatic writing machine and a paper tape punch. The reader is linked to the writing machine by a code translator, and the writing machine is linked to the punch by a code selector. Thus data punched in paper tape which is passed through the reader can be typed on to a document and also, if required, punched into the output tape.

The new models are the SFD and the SPS (or SPD), developed as part of a standardisation programme. Besides paper tape, Flexowriters can be arranged to read edge-punched cards and tabulating cards.

The SFD model is designed to deal with letter writing and simple systems work. Complete letters can be typed automatically at about 100 words per minute. Names and addresses are punched in tape or on edge-punched cards. The body of the letter is punched in another tape and spliced to obtain a loop. The tape is passed through an auxiliary tape reader which is connected with the Flexowriter.

If a variety of letters is wanted, each letter is given a code which is punched into the tape, followed by the letter. A Selectadata auxiliary tape reader is fitted with switches which allow any code allocated to be set up and a search made for it. This is carried out automatically at a speed of 22 codes per second, simultaneously with the printing of the name and address from the edge-punched card.

The SPS and SPD models are designed for systems work. The number of instruction codes to which they respond is greater than that of the SFD. Data punched in the tape being read can be punched in the output tape without being typed. Thus, where an output tape is required to produce another document and certain data is required only on the second document, this can be punched into the output tape card without its appearing on the first document.

Bulmers (Calculators) Ltd
47-51 Worship Street
London EC2

BOOKKEEPING EQUIPMENT

Electronic and conventional mechanical equipment will be shown on Stands 23 to 31 by Burroughs Adding Machine Limited. It will include a new dual-print electronic bookkeeping machine, which posts ledger and statement simultaneously. Integrated with it will be the Burroughs auto-reader which automatically feeds forms and reads balances, plus or minus, electronically from stripe-coded forms, transmitting the data to the electronic posting machine for listing in the form of trial balance or for balance transfers to new statement forms.

The F 2000 computer, on show for the first time, will be demonstrated at work on stores records. It is an inexpensive computer providing considerable programming flexibility. The E 101 desk-size computer, with increased storage capacity, will also be exhibited.

Burroughs Adding Machine Limited
Avon House
356 Oxford Street
London W1

DEVELOPED FROM THE PIANOLA

The Auto-Typist machines which are being shown by the British Equipment Co Ltd were developed from the original pianola automatic player pianos. They will operate any make of typewriter, manual or

On show for the first time the Burroughs F 2000 computer is an inexpensive desk-size machine.

electric, giving an output of individually typed letters.

A number of complete letters, or a series of paragraphs, can be prepared. Standard paragraphs can be combined in different ways to provide letters for different occasions. The letters or paragraphs are stored in the Auto-Typist on a perforated roll from which the machine picks out the appropriate letter or paragraphs in the desired order and types them. Variable data can be inserted by hand.

British Equipment Co Ltd
Ixworth Place
London SW3

ELECTRONIC STATIONERY GUILLOTINE

To meet the need for a reliable method of separating continuous stationery at high speeds, A J Catlin Ltd. have introduced the Type P1001 automatic guillotine, which will be shown on Stand 146. It is a self-contained unit of the console type with its own built-in drive. The stack of processed stationery is placed in a recess at the front, runs over the top and is deposited on a hinged delivery table at the rear.

The stationery is fed through the machine by sprockets engaging with the sprocket holes in the margins of the forms. Before entering the guillotine, both margins can be trimmed off by means of separate trimming units whose position relative to the forms can be adjusted to trim off margins up to one inch wide. The forms then pass between the blades of the guillotine which separate the continuous strip into accurately predetermined lengths.

Operation of the guillotine is electronic, the moving blade being actuated by a solenoid controlled by the length adjustment. Push-buttons provide an inching feed for setting up individual cuts for testing and continuous operation.

An additional control engages the 'strip-cut,' by means of which the guillotine is caused to take two cuts in rapid succession. The distance between double-cuts is variable from almost zero to half an inch, so that it can be used either to excise perforations between forms to provide a clean edge all round, or to remove strips containing coding marks, colour codes and similar identifying marks.

The margins removed by the trimming units and the strips removed by strip-cutting drop through into a bin which can be placed into the base of the machine. The cut sets are deposited on the delivery table at the rear which, when not in use, folds down to form the rear panel of the console. The delivery table is of steel and is provided with magnetic fences. These are easily adjusted by sliding to the size of form being cut, so that a neat pile is formed. The machine can be fitted with a cutting unit for the longitudinal cutting of forms, so that two sections of a form printed side by side can be cut apart before guillotining.

The machine can cut stationery up to 20 inches wide, separating it into forms from half an inch to 14 inches long, in half-inch steps, and can deal with multiple sets of up to eight-part forms, with seven interleaved carbons. Output depends on the length of forms being cut; standard eight-inch forms are cut at the rate of 4,650 per hour, four-inch forms at 7,000 per hour. The unit is thus capable of dealing with the output of several computers, tabulators and similar office machines, or from a very large typing pool.

A J Catlin Ltd
Jasper Road
London SE19

NEW MAGNETIC CORE CALCULATOR

The data processing equipment to be shown by IBM United Kingdom Ltd will include the IBM 628 magnetic core calculator and the IBM 610 automatic decimal point computer, neither of which has been shown in Britain before. The IBM 305 Ramac will also be exhibited.

The IBM 628 will be engaged on material control, based on the procedure used by an aero-engine manufacturer, and on a payroll demonstration. The machine combines the simplicity of a control panel calculator with a large storage and program capacity. It is designed to work with a card printer and the highspeed 421 accounting machine. It has an

This Formaliner equipment, by Lamson Paragon, regulates continuous stationery to punched card accounting machines and computer output units.

input-output rate of 150 cards or lines of print per minute and an electronic storage capacity of 320 digits. There is a program of 160 steps with highspeed program skip forwards and backwards, giving in effect almost unlimited capacity.

The IBM 610 is a new mathematical calculator that can program itself. The factors of an equation are entered by means of a keyboard and the calculation is performed by depressing the appropriate operation keys. The result is automatically typed and the alignment of decimal points throughout the calculation is fully automatic. The program and data can be entered also by punched tape or control panel.

The applications of the IBM 305 Ramac vary from stock control and seat reservations on airlines to air traffic control and the recording of ships' movements in the North Atlantic. The speed and versatility of the Ramac store will be demonstrated at the exhibition.

IBM United Kingdom Ltd
101 Wigmore Street
London W1

MEDIUM-SIZED COMPUTER

The Type 1202 medium-sized electronic computer will be shown by International Computers and Tabulators Limited on Stand 69. This has a magnetic drum storage with a capacity of 4096 locations, with 80-column punched card input. Output is direct to a card-punching unit and a printing tabulator which work simultaneously, thus enabling 'exception' data to be printed out at the same time that data for further processing is punched into cards.

A range of punched card tabulating and electronic calculating machines will be shown by the same company on Stand 74. In the 21-column range there will be a new tabulator with coupled summary card punch which can handle a wider range of accounting work than has hitherto been possible with this series of machines.

A 40-column installation will be demonstrated, and 80-column and 160-column installations will be exhibited. The 80-column units will include an interpreter which can be used to interpret either round-hole or slotted-hole cards. It is the first machine of its kind to be publicly shown.

International Computers and Tabulators Limited
17 Park Lane
London W1

BUSINESS WRITING SYSTEMS

In the Lamson Paragon exhibit on Stand 34 there will be an exposition of modern methods of business forms writing, both systematically and mechanically, from the handwritten sales check to high-speed automatic data processing from the electronic computer.

'Writing' is used in its broadest sense to include investigation of routine procedures and suggestions for simplifying documentation with a view to improving efficiency and eliminating unnecessary writing.

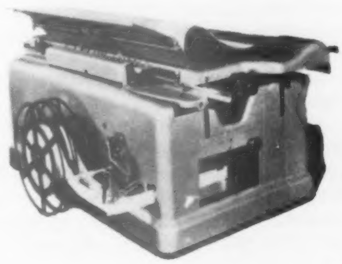
Among the exhibits on this stand will be cash and credit sales recording systems, manifold registers, continuous form systems for typewriters, accounting machines, teleprinters, tabulators and other high-speed printers as output media for computers.

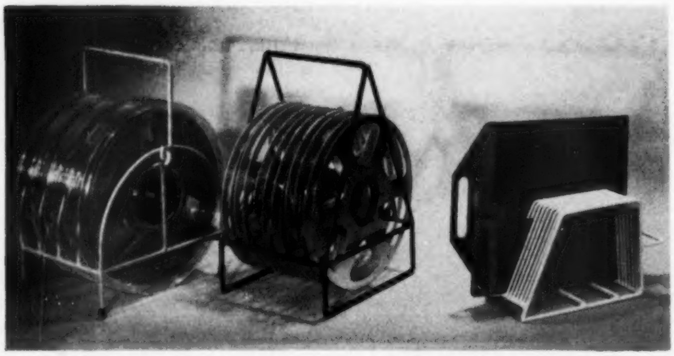
Lamson Paragon Limited
Queens House
28 Kingsway
London WC2

BUILT-IN TAPE PUNCH

A typewriter with built-in paper tape punch will be one of the exhibits by Mercedes Sterling. First introduced about a year ago, this will be shown on the electric typewriter model SE 4. An accounting machine, similarly equipped, will also be shown. This will be the first public exhibition of this equipment in Britain.

Left: The keyboard of the new IBM 610 decimal point computer. Right: The adapted Mercedes SE 4 accounting machine which perforates a paper tape.





Racks for paper and magnetic tape will be featured at the Punched Card Accessories Stand.

The accounting machine has full interchangeable programme bar control of the information punched on tape and an automatic link between the accounting machine tabulation on the keyboard and the automatic punching of spacing signals on tape.

Mercedes Sterling Bookkeeping and Calculating Machines Limited
11 Ludgate Circus
London EC4

BUILDING UP A COMPLETE SYSTEM

The theme running through the whole of the comprehensive exhibit of the National Cash Register Company Ltd will be to illustrate how a practical, complete automation system can be carried out by degrees and at low cost.

The exhibit will show how specific sections of an accounting plan can be automated largely by the adaptation of existing mechanical equipment. For example, the Class 31 direct-entry accounting machine will be shown coupled to the National 461/2 punched paper tape recorder to produce five-channel punched tape records of selected data for processing by electronic computer. A similar machine will be shown coupled to an automatic card punch to transcribe alpha-numerical basic data to cards for punched card accounting systems.

The National-Elliott 405 and 405M automatic data processing systems will be shown, with emphasis on their high capacity and flexibility. The 802 desk digital computer will be another exhibit of the company, which has engaged Stands 108 to 121.

National Cash Register Company Ltd
206-216 Marylebone Road
London NW1

ACCESSORIES

Among the items to be shown by Punched Card Accessories Ltd on Stand 122 are racks for the storage of punched paper tape and magnetic tape, designed to hold the tapes used with various computers. The company also specialises in designing equipment to conform to the demands of individual problems and applications.

Punched Card Accessories Ltd
Abbey House
Victoria Street
London SW1

AUTOMATIC XEROGRAPHIC MACHINE

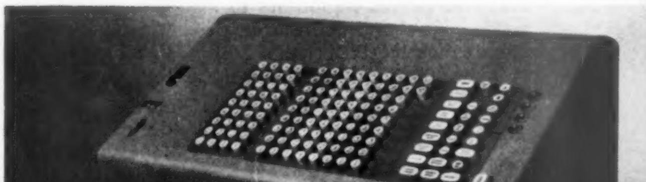
The Copyflo continuous printer will be exhibited by Rank-Xerox Ltd on Stand 126. The advantages of three up-to-date techniques—microfilm, punched cards and xerography—are combined in the one microfilm system. The original drawing or document is filmed on to a frame of 35mm microfilm, which is then processed and cut up into single frames. These are inserted into a special Filmsort punched card. When prints are needed the sorted cards are stacked in the Copyflo, which produces positive enlargements up to 24 inches in width.

As the Copyflo works by the electrostatic process of xerography, the prints are made on cheap, ordinary paper, or on to offset master material, linen, etc. It is an extremely versatile system which can accept a variety of forms of input.

Rank-Xerox Limited
33-41 Mortimer Street
London W1

TYPESCRIPTS BY PUNCHED CARDS

An electric typewriter synchronised with a Hollerith 80-column class 1000 Reader will be among the Remington Rand exhibits on Stands 109 to 120. Data from pre-punched Hollerith cards is faithfully interpreted by the Reader and



This ledger posting machine will be among National Cash's exhibits.

accurately reproduced by the typewriter at a speed of 480 characters per minute. ' Slave ' typewriters can be linked to the one reader unit and the whole keyboard of each fully exploited.

A sterling electric adding machine, model 93, incorporates bold innovations in design which ' touch method ' operators will much appreciate. New freedom and speed, it is claimed, are permitted by the ' handspan ' keyboard and balanced feature key placement. All feature keys—subtract, multiply, non-add, correction and add-total—are electrified. The same key allows a choice of automatic totals or sub-totals, printed in red. Negative totals—also in red—are instantly identified by the automatic ' CR ' symbol.

New filing systems include the Kardveyer model 4370 which combines a very large card-filing capacity with the minimum of floor space. It is electrically operated and any of 70 card trays can be brought to correct processing position in an average time of two-and-a-half seconds by a touch on the automatic push-button selection panel. The Kardveyer is quiet and entirely safe in operation.

For grouped filing, there is also the Classifile. This is literally six files in one folder; thus documents and records relating to the various aspects of one main heading are filed and found together.

Dictation by telephone has also received the company's attention. With the Ultravox remote control dictating system, push-button operation automatically engages a vacant dictating machine, thus distributing the typing load evenly. Full provision is made for playback and corrections. A new feaure is the provision of an ' end of letter ' indication on the record sheet.

Remington Rand Ltd
Commonwealth House
1-19 New Oxford Street
London WC1

Copyflo equipment (see opposite page) produces copies of documents at the rate of 20 feet a minute.

FEED UNIT FOR TABULATORS

A device to increase the output and flexibility of Hollerith tabulators is to be exhibited by W H Smith and Son (Alacra) Ltd. This is a dual-feed unit, enabling two continuously punched forms or sets of forms with different spacing to be accurately aligned, fed and imprinted simultaneously.

It consists of two overhead pinwheel feeding devices, a programmed line feed mechanism and a carbon release unit.

The line feed mechanism provides single or double line spacing from one impulse from the tabulator, positive selection of any writing line within the body of a form predetermined by the programme, automatic positioning of the first writing line of each form and other advantages.

W H Smith and Son (Alacra) Ltd
Park Royal Road
London NW10

INTEGRATED DATA FLOW

Underwood Business Machines Limited will be exhibiting their Dataflo system. This consists of a number of automatic electric typewriters, totalizers, tape punches and readers, which can be programmed to suit the needs of industrial, commercial and administrative organisations in integrated data processing systems.

Punched paper tape and tabulating cards are the integrating link between the various machines, and both are produced in five-, six-, seven- or eight-channel codes as a by-product of the typing of original documents. The tape or cards can contain all the typed information or automatically selected sections.

The Dataflo units can be operated separately or simultaneously or in different localities. An interchangeable plugboard control panel automatically sequences and controls the functions of the various components, which may or may not include a computer.

Underwood Business Machines Limited
4-12 New Oxford Street
London WC1

INDEX TO ADVERTISERS

Printed for the Proprietors, BUSINESS PUBLICATIONS Ltd., *registered office:* 180 *Fleet Street, London, E.C.4, England (Waterloo* 3388) by Samuel Temple & Co. Ltd., Vencourt Place, King Street, London, W.6.
Advertisement, editorial and sales offices: Mercury House, 109-119 Waterloo Road, London, S.E.1 (Waterloo 3388)